INSTITUTE OF MACROMOLECULAR CHEMISTRY CAS

INTERNATIONAL POLYMER COLLOID GROUP

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

EUROPEAN POLYMER FEDERATION

FRONTIERS OF POLYMER COLLOIDS

From Synthesis to Macro-Scale and Nano-Scale Applications

84th PRAGUE MEETING ON macroMOLECULES

BOOK OF ABSTRACTS

INSTITUTE OF MACROMOLECULAR CHEMISTRY
CZECH ACADEMY OF SCIENCES

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24–28 July 2022, Prague

BOOK OF ABSTRACTS

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macroMOLECULES

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84th PRAGUE MEETING ON MACROMOLECULES

under the auspices of the
International Polymer Colloid Group
International Union of Pure and Applied Chemistry
European Polymer Federation

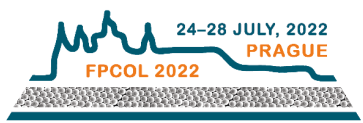
Organized by the Institute of Macromolecular Chemistry,
Czech Academy of Sciences

Daniel Horák
Conference Chairman

Jiří Kotek
Director of the Institute

Beata Anna Zasońska, Marcela Havelková, Marie Rodová and
members of the Department of Polymer Particles
Local Organizing Team

Josef Jůza, Jiří Kaprálek
Technical Support



We thank the sponsors of the Conference

Prague, July 2022

FRONTIERS OF POLYMER COLLOIDS
From Synthesis to Macro-Scale
and Nano-Scale Applications

Dear friends, colleagues and supporters of polymer colloids,

I am very pleased to see you here in Prague on the occasion of opening of an important conference, returning us fortunately to face-to-face meetings after a longer time. We have called it “Frontiers of Polymer Colloids” as it covers a wide range of issues, from the latest innovative developments in synthesis and characterization of colloids to their macroscale and nanoscale applications. The scientific program of the meeting includes four keynote and seventeen main lectures and almost forty oral and numerous poster presentations that will provide the chance to discuss and share new ideas, learn about new developments, and compare viewpoints from academic and industrial research fellows.

Let me remind that the Polymer Colloids Conference is a part of the Prague Meetings on Macromolecules organized since 1967 by the Institute of Macromolecular Chemistry of the Czech Academy of Sciences, a leading research institution in the field of synthetic polymers. The conference is held under the auspices of IUPAC and the European Polymer Federation and is also supported by the International Polymer Colloid Group. At the last meeting on Polymer Colloids in 2019 in Singapore, we planned the next conference in 2020. At that time, no one could have guessed how turbulent times awaited us. The global coronavirus pandemic has affected our lives for more than two years and we had to postpone our meeting twice. Beyond all bearings, the unexpected and absurd Russian aggression on Ukraine in February this year led to great sacrifices and prevented many of our colleagues from participating.

As the conference is taking place in a wonderful city of Prague, you can discover also the best of our city from iconic sightseeing spots of the Charles Bridge to the Castle District, gardens of the Lesser Town, and magical Old Town during the social program of the meeting. Please, select and join one of our four planned sightseeing tours completed with a conference dinner at the Břevnov monastery on Wednesday!

I would like to thank all of you for your participation and important scientific contributions to the technical program. I am sure that everybody interested in polymer colloids and their industrial and biomedical applications will enjoy this meeting.

Daniel Horák

Conference Chairman

GENERAL INFORMATION

Venue

All sessions will be held at the Institute of Macromolecular Chemistry, Czech Academy of Sciences, Heyrovského nám. 2, 162 06 Prague 6, Czech Republic.

Language

The official language of the conference is English.

Registration

On-site registration will take place on Sunday, July 24, 2022, from 16:00 till 19:00 at the Institute of Macromolecular Chemistry and will continue the next day from 8:00 till 16:00. Please be aware that only persons wearing name badges received upon registration will be entitled to enter the lecture rooms at the Institute.

PRESENTATIONS

The conference presentations will consist of opening lecture, keynote lectures, main lectures and special lectures. Poster session will be held on Monday, July 25, 2022.

The time allocated for lectures, including questions and discussion:

Opening lecture: 45 min.

Keynote lectures: 35 min.

Main lectures: 30 min.

Special lectures: 15 min.

Uploading presentation files

We recommend that you upload your presentation at least one session ahead of your lecture. The IT administrator Jiří Kaprálek will help you upload and check your presentation. Please, use your last name as the presentation file name.

Recordings

Audio/video recording or copying of lecture files is not allowed without the prior consent of the speaker. The organizers reserve the right to take photographs for documentation during the meeting. In case you do not want to be photographed, please kindly inform the photographer or organizers.

Poster presentations

Materials for fixing the posters will be provided onsite. The posters can be mounted at the beginning of the poster session, and they should be removed after the session. The area reserved for mounting a poster is 200 cm high by 100 cm wide.

Poster session

Monday, July 25, 2022, 17:35 – 19:00

The scientific committee will evaluate the three best posters. The winners will be announced at the conference dinner and awards amounting to 300, 200, and 100 EUR will be distributed by the scientific committee chair.

REFRESHMENTS AND LUNCHES

Coffee and small refreshment will be served during breaks each day. Lunch buffets will be open from Monday till Thursday in the dining hall of the Institute. The cost of refreshments and lunches is included in the conference fee as well as the welcome buffet and the conference dinner.

SOCIAL EVENTS

The costs of the following social events are included in the conference fee. Accompanying persons can pay for the Wednesday afternoon program and conference dinner at the registration desk.

Sunday, July 24, 2022

16:00 – 19:00 **Registration and Welcome Buffet**

Participants of the conference will register and receive the conference materials.

Monday, July 25, 2022

After the end of the poster session at 19:00, we will have dinner together at the Institute premises.

Tuesday, July 26, 2022

The evening is free. Enjoy!

Wednesday, July 27, 2022

Guided Tours of Prague

The tours will depart from the conference venue at 14:00 and will end in the city by 17:00.

1. The Prague Castle Tour

Well-known and hidden places of the biggest castle in the world

The Prague Castle promises a breathtaking journey through one thousand years of Czech history. Four powerful European dynasties ruled Bohemia from this monumental complex, where a variety of architectural styles mingle together. Let us explore three castle courtyards and then enter the magnificent St. Vitus Cathedral, where the artworks of old medieval masters are displayed, as well as those in modern Art Nouveau style. Then, we will continue to the Old Royal Palace and follow to the Golden Lane, where the common people used to live.

2. The Old Town and Charles Bridge Tour with a Boat Trip

The oldest area of Prague – for the real history lovers

The Charles Bridge is a unique historical site renowned worldwide. It is undoubtedly one of Prague´s main cultural symbols considered to be the energy center of the city. Let us cross it and learn more about its history and mystery. Afterward we will go to the Old Town, the oldest of four historical districts of Prague. Its center and main attraction is the Old Town Square with the Astronomical Clock. As a bonus, there will be a boat trip and everyone can enjoy the city on the waves of the Čertovka canal which flows in the Vltava river.

3. Gardens and Parks Tour in Lesser Town

The most scenic area of Prague with its specific genius loci

This tour will take us through the gardens and parks of Lesser Town, the second oldest historical district of Prague founded in the 13th century. In the beginning, a spacious baroque Wallenstein garden will charm you, together with the neighboring Wallenstein palace, nowadays seat of the Czech Senate. The tour will continue through the Vojan Gardens, a former convent orchard founded in 1248. As the highlight of the tour, we will see the splendid Vrtba Garden situated on the slope of Petřín hill. After enjoying the breathtaking views, we will stop at the Church of Our Lady Victorious with the miraculous "Infant Jesus of Prague".

4. Prague in Legends

Fantasy or reality? Believe or not, it is up to you…

Prague is a very old city that enchants all of its visitors, mostly due to baroque architecture and preserved historical center. However, would you like to see the hidden corners, tiny narrow streets, and secret passages? They reveal more than the "ordinary" beauty of the city, unfolding its magical power. Join this tour and learn about Prague mysteries, fairy tales, and legends. Visit places with scary ghosts and miraculous locations, where people´s wishes come true. As a bonus, we will enjoy a beautiful view from a medieval tower at the end of the tour.

19:00 Conference dinner at the Břevnov Monastery

Markétská 1/28, Prague 6
(tram no. 22 and 25, "Břevnovský klášter" stop)

At the end of the tours, we will have a wonderful dinner at representative rooms of the Břevnov Monastery, a Benedictine archabbey, founded by Saint Adalbert, the second Bishop of Prague, in 993, with the support of Bohemian Duke Boleslaus. In addition to the splendid history and architecture, the monastery is famous for its Břevnovský Benedict beer from one of the oldest breweries in the Czech Republic.

PRAGUE TRANSPORT

Public transport

In the conference materials, you will find a special congress ticket valid from Monday 25th till Thursday 28th of July 2022. With the ticket, you can travel by all means of public transport (trams, buses, metro, funicular) with an unlimited number of transfers. Besides that, you can buy a ticket for 30 CZK valid for a 30-min journey or a ticket for 40 CZK valid for a 90-min journey. The 24-h ticket costs 120 CZK. Tickets are sold at the airport, railway, and metro stations, newspaper stands, hotel reception desks, etc. Inside the trams, tickets can be purchased using a contactless payment card. The metro runs from 5:00 until midnight. Ticket machines accepting contactless payment cards are at the tram stop and metro station near the conference venue. Persons over 65 years can travel for free; however, when checked by an inspector, they have to show passports.

Airport and railway stations

The Václav Havel Airport Prague is situated 9 km from the Institute, with a comfortable connection by bus No. 191 to/from the "Sídliště Petřiny" stop next to the Institute (the stop is on request). International trains mainly arrive at the "Praha Hlavní nádraží" station ("Hlavní nádraží" metro station, red line C). **The Institute is situated near the "Petřiny" metro station, green line A.**

EMERGENCY PHONE NUMBERS

General emergency:	112
Medical ambulance service:	155
Police:	158

CONFERENCE PROGRAM

Sunday, July 24, 2022

16:00 – 19:00	**Registration and Welcome Buffet**

Monday, July 25, 2022

9:00 – 9:05	**OPENING** Jiří Kotek (Director of the Institute) Daniel Horák (Conference Chairman)

LECTURE SESSION 1

Chaired by: Michael Cunningham (Canada)

9:05 – 9:50	Opening lecture OL-01 **Katharina Landfester** *(Germany)* Catalytical reactions in nanocapsules for biomedical applications and synthetic biology
	SYNTHESIS
9:50 – 10:25	Keynote lecture KL-01 **Craig J. Hawker** *(USA)* Polymer assemblies and nanoparticles through stereocomplexation
10:25 – 10:55	Main lecture ML-01 **José M. Asua** *(Spain)* Particle morphology of polymer colloids. From reactor to film
10:55 – 11:15	*Coffee break*

LECTURE SESSION 2

Chaired by: Elodie Bourgeat-Lami (France)

	SYNTHESIS
11:15 – 11:45	Main lecture ML-02 **Michael Cunningham** *(Canada)* Graft modification of starch nanoparticles via nitroxide mediated polymerization
11:45 – 12:00	Special lecture SL-01 **Mauricio Balarezo** *(France)* Design of biobased (co)polymers and nanoparticles through emulsion/dispersion polymerization of biosourced monomers in green solvent
12:00 – 12:15	Special lecture SL-02 **Marie Raffin** *(France)* Design of new macromolecular stabilizers incorporating vinyl alcohol units for the emulsion (co)polymerization of vinyl acetate
12:15 – 12:30	Special lecture SL-03 **Takaichi Watanabe** *(Japan)* Microfluidic formation of multilayer microcapsules by sequential liquid–liquid phase separation
12:30 – 14:00	*Lunch*

LECTURE SESSION 3

Chaired by: Katharina Landfester (Germany)

SYNTHESIS

14:00 – 14:30	Main lecture ML-03 **Patrick Lacroix-Desmazes** *(France)* Synthesis of biobased latexes from renewable aromatic building blocks by (mini)emulsion polymerizations
14:30 – 14:45	Special lecture SL-04 **Jan Labuta** *(Japan)* Phase separation and pH-dependent behavior of star-shaped porphyrin-PNIPAM$_4$ conjugates
14:45 – 15:00	Special lecture SL-05 **Jutta Rieger** *(France)* Exploring the synthesis of polymeric nanofibers by templated polymerization-induced self-assembly
15:00 – 15:15	Special lecture SL-06 **Clément Debrie** *(France)* Are unimer exchanges necessary to form higher order morphologies in PISA?
15:15 – 15:30	Special lecture SL-07 **Bas van Ravensteijn** *(Netherlands)* Polymerization-induced assembly of polyelectrolytes and colloidal particles
15:30 – 15:45	Special lecture SL-08 **M. Ali Aboudzadeh** *(France)* Cyclic polyethylene glycol as gold nanoparticle surface ligand: Synthesis and colloidal stability
15:45 – 16:05	*Coffee break*

LECTURE SESSION 4

Chaired by: Olivier Sandre (France)

	SYNTHESIS
16:05 – 16:35	Main lecture ML-04 **Elodie Bourgeat-Lami** *(France)* Visible light-induced photopolymerization in dispersed media: Synthesis of conventional and inorganic-armored latexes
16:35 – 16:50	Special lecture SL-09 **Peter Krajnc** *(Slovenia)* Poly(thiol-enes) through colloidal templating
16:50 – 17:05	Special lecture SL-10 **Sandra Smeltzer** *(Canada)* Self-assembly of amphiphilic block-random copolymers in aqueous solutions
17:05 – 17:20	Special lecture SL-11 **Stephen Foulger** *(USA)* Manipulating the intraparticle Förster resonance energy transfer of organized radioluminescent particles
17:20 – 17:35	Special lecture SL-12 **Jonghwi Lee** *(Republic of Korea)* Water flow generated by thermo-responsive volume change of hydrogels powered by diurnal temperature variation
17:35 – 19:00	**Poster Session**
19:00 – 22:00	**Dinner at Institute premises**

Tuesday, July 26, 2022

LECTURE SESSION 5

Chaired by: Stefan A. F. Bon (United Kingdom)

BIOMEDICAL	
9:00 – 9:35	Keynote lecture KL-02 **John A. Capobianco** *(Canada)* Upconversion: Odyssey
9:35 – 10:05	Main lecture ML-05 **Brigitte Voit** *(Germany)* Responsive polymeric nanocapsules and multi-compartments as cellular mimics
10:05 – 10:35	Main lecture ML-06 **Dietmar Appelhans** *(Germany)* Colloidal systems for the fabrication of cell mimics and protocells
10:35 – 10:50	Special lecture SL-13 **Christine M. Papadakis** *(Germany)* Cononsolvency in self-assembled, thermoresponsive micelles from PMMA-PNIPAM
10:50 – 11:10	*Coffee break*

LECTURE SESSION 6

Chaired by: Hideto Minami (Japan)

	SYNTHESIS
11:10 – 11:40	Main lecture ML-07 **Per Bo Zetterlund** *(Australia)* Multiblock copolymer synthesis and nanoparticle engineering using RAFT emulsion polymerization
11:40 – 12:10	Main lecture ML-08 **Olivier Sandre** *(France)* Copolymers with pH-sensitive polypeptide block: Synthesis and self-assembly into polymersomes
12:10 – 12:25	Special lecture SL-14 **Ognen Pop-Georgievski** *(Czech Republic)* Biofunctional polymer brush coatings on the nanoscale
12:25 – 14:00	*Lunch* **International Polymer Colloid Group Meeting – rooms B and C**

LECTURE SESSION 7

Chaired by: José M. Asua (Spain)

BIOMEDICAL

14:00 – 14:30	Main lecture ML-09 **Stefan A. F. Bon** *(United Kingdom)* Supracolloidal chemical engineering: Towards "greener" polymer colloid-based materials and products
14:30 – 14:45	Special lecture SL-15 **Lénaïc Lartigue** *(France)* Superferrimagnetic curcumin derivatives nanodispersion for magnetic fluid hyperthermia
14:45 – 15:00	Special lecture SL-16 **Cornelia G. Palivan** *(Switzerland)* Amphiphilic block copolymers: From synthesis towards biomimetic polymer membranes
15:00 – 15:15	Special lecture SL-17 **Elisabeth Trinh** *(United Kingdom)* Using bridging flocculation for the development of a polymer-based point-of-care diagnostic for targeted detection of DNA
15:15 – 15:30	Special lecture SL-18 **Rafael Piñol** *(Spain)* Luminescence nanothermometry technology for intracellular temperature imaging
15:30 – 15:45	Special lecture SL-19 **Yubing Hu** *(United Kingdom)* Optical biosensors via holographic lithography
15:45 – 16:05	*Coffee break*

LECTURE SESSION 8

Chaired by: Per Bo Zetterlund (Australia)

SYNTHESIS

16:05 – 16:35 Main lecture ML-10
Hideto Minami *(Japan)*
Preparation of non-spherical polymer particles by mechanical process

16:35 – 16:50 Special lecture SL-20
Sam Li *(Singapore)*
Nanoparticle-imprinted hydrogel for selective recognition of nanoparticles in water samples

16:50 – 17:05 Special lecture SL-21
Daewon Sohn *(Republic of Korea)*
Structures and properties of hydrogels controlled by coordination bond geometries

17:05 – 17:20 Special lecture SL-22
Friederike Dehli *(Germany)*
Hydrogel foams based on biotinylated gelatin methacryloyl for improved enzyme substrate conversion

17:20 – 17:35 Special lecture SL-23
Iva Rezić *(Croatia)*
Modification of polymers with powerful antimicrobial coatings

Wednesday, July 27, 2022

LECTURE SESSION 9

Chaired by: C. J. Hawker (USA)

	BIOMEDICAL
9:00 – 9:35	Keynote lecture KL-03 **Karen Wooley** *(USA)* Natural product-based polymers that address health-food-energy-water challenges
9:35 – 10:05	Main lecture ML-11 **Abdelhamid Elaissari** *(France)* Sponge like biodegradable microparticles for cosmeto-therapy textile
10:05 – 10:20	Special lecture SL-24 **Ghazaleh Azizi Saadatlou** *(Turkey)* Multifunctional layer-by-layer coatings for cardiovascular metallic stents
10:20 – 10:35	Special lecture SL-25 **Tomasz Panczyk** *(Poland)* Interaction of non canonical telomeric DNA fragments with carbon nanotubes in aqueous solutions. Insights from molecular simulations
10:35 – 10:50	Special lecture SL-26 **Edurne Gonzalez** *(Spain)* Novel composite nanofibers by green electrospinning
10:50 – 11:10	*Coffee break*

LECTURE SESSION 10

Chaired by: Karen Wooley (USA)

	BIOMEDICAL
11:10 – 11:40	Main lecture ML-12 **Matthias Ballauff** *(Germany)* Polymer colloids interacting with proteins
	CHARACTERIZATION
11:40 – 12:10	Main lecture ML-13 **Teresa Basinska** *(Poland)* Hydrophilic prolate spheroids: Preparation, properties and formation of structured materials
12:10 – 12:25	Special lecture SL-27 **H. Daniel Ou-Yang** *(USA)* Visualizing diffusiophoresis and particle-size-segregation in a drying colloidal droplet containing mixed-sized particles
12:25 – 12:40	Special lecture SL-28 **Kamil Awsiuk** *(Poland)* Poly(*tert*-butyl methacrylate) film interactions with peptides, proteins, and bacteria: Effect of polymer stereoregularity
12:40 – 12:55	Special lecture SL-29 **Miren Aguirre** *(Spain)* Waterborne degradable polyester nanoparticles
12:55 – 14:00	*Lunch*
14:00 – 17:00	**Social program (Guided tours in Prague)**
19:00 – 22:00	**Conference dinner**

Thursday, July 28, 2022

LECTURE SESSION 11

Chaired by: Abdelhamid Elaissari (France)

BIOMEDICAL	
9:00 – 9:35	Keynote lecture KL-04 **Yukio Nagasaki** *(Japan)* Pharmacologically active polymer micelles for novel therapeutics
9:35 – 9:50	Special lecture SL-30 **Babita Shashni** *(Japan)* Enzyme metabolizable PEG-b-poly(vinyl butyrate) nanomedicine sensitizes cancer to the radiotherapy
INDUSTRY	
9:50 – 10:20	Main lecture ML-14 **Alex van Herk** *(Netherlands)* Cool coatings; application of core-shell latex particles in functional coatings
10:20 – 10:50	Main lecture ML-15 **Bernd Reck** *(Germany)* Acrylic polymer dispersions – from colloidal structure to application properties
10:50 – 11:05	Special lecture SL-31 **Arthur Werner** *(Canada)* Latexes stabilized by amphiphilic block-random copolymers
11:05 – 11:25	*Coffee break*

LECTURE SESSION 12

Chaired by: Alex van Herk (Netherlands)

CHARACTERIZATION	
11:25 – 11:55	Main lecture ML-16 **John Tsavalas** *(USA)* Patience is a virtue in the design of anisotropic particle morphology
11:55 – 12:10	Special lecture SL-32 **Yang Liu** *(Canada)* Mechanistic studies of latex film formation of low VOC waterborne coatings
12:10 – 12:25	Special lecture SL-33 **Chi Hoong Chan** *(Malaysia)* Reprocessable and tunable nitrile elastomers enabled by covalent adaptable networks using a reactive epoxy polymeric crosslinker prepared via emulsion polymerization
12:25 – 12:40	Special lecture SL-34 **Gabor Ersek** *(Netherlands)* Influence of solvent exposure on clear, soft polyurethane and polyacrylate@polyurethane coatings
12:40 – 14:00	*Lunch*

LECTURE SESSION 13

Chaired by: John Tsavalas (USA)

	CHARACTERIZATION
14:00 – 14:30	Main lecture ML-17 **Stepan Podzimek** *(Germany)* Light scattering for structural studies of colloidal materials
14:30 – 14:45	Special lecture SL-35 **Pei Li** *(People's Republic of China)* Synthesis of multi-carbon dots crosslinked polyethyleneimine particles for biological application
14:45 – 15:00	Special lecture SL-36 **Edina Rusen** *(Romania)* Core-shell particles with thermo-responsive wetting characteristics obtained by photo-mediated suspension polymerization
15:00 – 15:15	Special lecture SL-37 **Djamal Tahtat** *(Algeria)* Study of the encapsulation efficiency of vitamin B1 in alginate beads: Application of an experimental design
15:15 – 15:25	**Conclusion, Path forward**
15:25	**FAREWELL**

LIST OF POSTERS

P-01 **C. Sanders**, S. Smeltzer, A. Werner, S. George, A. Gernandt, B. Reck, M. F. Cunningham *(Canada)*
Amphiphilic block-random copolymers as stabilizers in emulsion polymerization

P-02 I. L. S. Tolentino, P. H. H. Araujo, **C. Sayer** *(Brazil)*
Myrcene thiol-ene miniemulsion polymerization

P-03 **T. Vasylyshyn**, V. Patsula, D. Horák *(Czech Republic)*
Poly(2,3-dihydroxypropyl methacrylate)/upconverting nanoparticles via miniemulsion RAFT polymerization

P-04 B. Perez, O. Gomez de Miranda, **R. Rodriguez** *(Spain)*
Effect of epoxidized soybean oil acrylation degree on the development of biobased system by miniemulsion polymerization

P-05 M. Tarhini, **S. Khizar**, M. Hangouet, G. Guignard, A. Hervault, A. Elaissari *(France)*
Encapsulation of dye inside latex particles via polymerization in disperse media

P-06 **P. Šálek**, D. Zbořilová, E. Pavlova, O. Trhlíková, O. Šebestová Janoušková *(Czech Republic)*
Poly[*N*-(2-hydroxypropyl) methacrylamide]-based nanogel prepared by dispersion polymerization for live-cell imaging

P-07 **D. N. Crisan**, M. Onea *(Romania)*
Grafting strategies for the synthesis of polyhydrazide-gold nanoparticles

P-08 **A. Jäger**, E. Jäger, K. L. Cavalcante, V. Sincari, E. Pavlova, M. Hrubý *(Czech Republic)*
Microfluidic fabrication of monodisperse biocompatible and biodegradable polymer nanoparticles

P-09 **A. Medaj**, J. Odrobińska-Baliś, K. Minor, A. Kmak, S. Zapotoczny *(Poland)*
Polymer nanocapsules templated on liquid cores as a potential nanoreactors

P-10 **R. Nebesnyi**, T. Kharandiuk, A. Pavliuk, V. Ivasiv, K. H. Tan, A. Pich *(Ukraine)*
Selenium-modified microgels as bio-inspired catalysts for unsaturated aldehydes oxidation

P-11 **A. Angelini**, A. Car, L. Leva, W. Yave, I. A. Dinu *(Switzerland)*
Polystyrene-*block*-poly(vinyl alcohol) nanostructured self-assemblies for preparation of pervaporation membranes

P-12 **L. Kratofil Krehula**, D. Jakus, A. Peršić, A. Kapitanović, H. Otmačić Ćurković *(Croatia)*
Conductive polymer hydrogels based on poly(vinyl alcohol)

P-13 **F. Grabowski**, V. S. Petrovskii, F. Fink, S. Herres-Pawlis, I. Potemkin, A. Pich *(Germany)*
Asymmetric microgels by supramolecular assembly and precipitation polymerization of pyrazole-modified monomers

P-14 **Y. Jeong**, N. Q. Nguyen, H. Y. Cho, D. Sohn *(Republic of Korea)*
Internal structure of hydrogel containing laponite and temperature-responsive poly(*N*-isopropylacrylamide)

P-15 **T. Z. Abolibda**, A. P. Abbott *(Saudi Arabia)*
Gelation of starch polymer in a hydrogen bond donor based modifier

P-16 **A. García**, A. Román *(Mexico)*
Liquid-liquid and liquid-solid separation in self-assembled polysaccharides complexes

P-17 **L. Scholtz**, J. G. Eckert, T. Elahi, F. Lübkemann, N. C. Bigall, U. Resch-Genger *(Germany)*
Luminescence encoding of polymer microbeads during polymerization

P-18 **A. Sikorski**, P. Polanowski, K. Hałagan *(Poland)*
Star-branched polymers vs. dendrimers. A computer simulation study

P-19 **J. Hildebrandt**, A. F. Thünemann *(Germany)*
Polypropylene nanoplastics dispersed in water as reference materials

P-20 M. Paúrová, **M. Babič**, I. Šeděnková, J. Hromádková, P. Matouš *(Czech Republic)*
Polymer particles as contrast agents for photoacoustic tomography

P-21 **M. Deuker**, S. Morsbach, V. Mailänder, K. Landfester *(Germany)*
Interaction of nanocarriers with anti-PEG antibodies

P-22 **I. A. Dinu**, M. V. Dinu, W. Meier, N. Bruns *(Switzerland)*
Trehalose-coencapsulation in polymer nanocompartaments for stabilizing and protecting protein functionality

P-23 **S. Dutz**, D. Zahn, S. Jung, J. Dellith, K. Saatchi, U. O. Häfeli *(Germany)*
Magnetic microspheres for hyperthermia, drug delivery, and immunomagnetic separation

P-24 J. M. Beltrame, C. Guindani, C. Sayer, A. D. Zottis, **P. H. H. Araujo** *(Brazil)*
Bioconjugation of superparamagnetic nanoparticles coated with unsaturated polyester

P-25 **A. B. Shatan**, D. Horák *(Czech Republic)*
Design, synthesis and bactericidal activity of polymer-coated magnetic nanoparticles

P-26 **M. A. Świętek**, L. Lartigue, T. Vasylyshyn, R. Konefał, D. Horák *(Czech Republic)*
Curcumin-based nanoassemblies modified with prooxidant for magnetic hyperthermia

P-27 **V. Patsula**, H. Macková, M. A. Świętek, V. Oleksa, D. Horák *(Czech Republic)*
Antioxidant Poly(6-*O*-methacryloyl-*L*-ascorbic acid)-modified magnetite nanoparticles

P-28 **M. Moskvin**, I. Marková, V. Huntošová, D. Horák *(Czech Republic)*
Biological activity of multifunctional nanoparticles based on iron and cerium oxides

P-29 M. Nahorniak, O. Pop-Georgievski, N. Velychkivska, M. Filipová, **U. Kostiv**, D. Horák *(Sweden)*
Rose bengal-modified upconversion nanoparticles

P-30 **V. Oleksa**, V. Patsula, H. Macková, D. Horák *(Czech Republic)*
Poly(*N,N*-dimethylacrylamide)-coated upconverting core-shell nanoparticles for biomedical applications

P-31 **O. Shapoval**, V. Oleksa, D. Horák *(Czech Republic)*
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P-32 **B. A. Zasońska**, D. Horák *(Czech Republic)*
Porous silica-based magnetic nanoparticles for drug delivery

P-33 **A. Hlukhaniuk**, V. Patsula, M. A. Świętek, J. Hodan, B. A. Zasońska, D. Horák *(Czech Republic)*
Magnetic nanoparticles as additives to polymer composites

P-34 **P. Menold**, N. Preisig, C. Stubenrauch, R. Strey *(Germany)*
A transition from a sponge-like to a foam-like nanostructure in water-rich L_3 phases

P-35 **K. A. Milakin**, U. Acharya, I. M. Minisy, D. V. Tumacder, Z. Morávková, O. Taboubi, T. Syrový, J. Pfleger, P. Bober *(Czech Republic)*
Polyaniline-phytic acid-poly(*N*-vinylpyrrolidone) films with controllable hydrophobicity

P-36 V. Dinca, **A. Mocanu**, G. (Niță) Toader, E. Rusen, A. Diacon *(Romania)*
Surface modification using MAPLE technique for improving mechanical performance of adhesive joints

P-37 S. Benamer-Oudih, **D. Tahtat**, A. Nacer Khodja, M. Mahlous, Y. Hammache, A. Guittoum, S. Kebbouche Gana *(Algeria)*
Synthesis of chitosan nanoparticles with controlled size and zeta potential: Application of factorial experimental design

P-38 **D. Tahtat**, S. Benamer-Oudih, A. Nacer Khodja, Y. Hammache, M. Mahlous *(Algeria)*
Study of the swelling rate of superabsorbent sodium acrylate/ locust bean gum synthetized by gamma radiation

NOTES

OPENING LECTURE

OL-01

CATALYTICAL REACTIONS IN NANOCAPSULES FOR BIOMEDICAL APPLICATIONS AND SYNTHETIC BIOLOGY

K. Landfester

Max Planck Institute for Polymer Research, Ackermannweg 10, 55128 Mainz, Germany

Since many years, there is a quest for minimal cells in the field of synthetic biology, potentially allowing a maximum of efficiency in biotechnological processes. Although the so-called "protocells" are usually referred to in all papers that attempt a cumulative definition of Synthetic Biology, research in this area has been largely under-represented. Our aim is at developing vesicular structures, i.e. protocells, based on block copolymer self-assembly and engulfed nanocontainers with incorporated functions, such as energy production and the control of transport properties through nanomembranes. Therefore, we have designed and developed nanocapsules that act as cell-like compartments and can be loaded with enzymes or synthetic catalysts for synthetic biology and chemistry. These nanocapsules can be used for biomedical application. In addition, self-assembly of well-defined diblock copolymers has been used to generate polymersomes and hybrid liposomes/polymersomes. Both strategies allow the compartimentalization on the nano- or microscale and conducting enzymatic or chemical reactions in the confinement of the polymersomes/ nanocarriers. New block copolymers and permeable nanocarriers have been synthesized and optimized. With these protocols we were able to establish an enzymatic reaction cascade within droplet-based compartments. These confined compartments can act as cell-like functions to regenerate NAD. For these tasks, novel conductive polymer nanoparticles have been developed which will be included into the protocells for the NAD regeneration by light. Enzyme-complexes are assembled that will fulfill these requirements.
In eukaryotic cells, enzymes are compartmentalized in specific organelles so that different reactions and processes can be performed efficiently and with a high degree of control. We show that these features can be artificially emulated by applying an enzyme co-compartmentalization strategy. We developped an *in-situ* encapsulation approach for the enzymes so that a defined amount and group of enzymes can be loaded into single

nanoreactors. The nanoreactors can be assembled as modules in an integrated system in order to produce a desired reaction outcome. Based on the selective co-compartmentalization of enzymes we were able to favour a desired pathway in competitive cascade reactions and increase the entire reaction kinetics of sequential cascade reactions. Additionally, the nanoreactors can be loaded into giant polymer vesicles, resulting in multi-compartmentalized artificial cells with integrated cascade reactions.
We also present an artificial enzyme combination to produce NAD^+ continuously; no additional organic substrates are required once a minimal amount pyruvate is supplied, and no accumulation of byproducts is obtained. Three enzymes are covalently encapsulated into a silica nanoreactor to develop the continuous NAD+ regeneration system. The enzymes retain their activity inside of the nanoreactors and are protected against proteolysis and heat. We successfully used the nanoreactors for i) sensing glucose in artificial glucose metabolism, and ii) reducing the non-oxygen binding methemoglobin to oxygen-binding hemoglobin.

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KEYNOTE LECTURES

KL-01

POLYMER ASSEMBLIES AND NANOPARTICLES THROUGH STEREOCOMPLEXATION

C. J. Hawker

Materials Research Laboratory MC 5121
University of California, Santa Barbara, CA 93106-5121, USA
(hawker@mrl.ucsb.edu)

DNA-mediated assembly of inorganic particles has demonstrated to be a powerful approach for preparing nanomaterials with a range of interesting optical and electrical properties. Building on this inspiration, we describe a generalizable gram-scale method to assemble nanoparticles through the formation of poly(methyl methacrylate) (PMMA) triple-helices. In this work, alkene-terminated */syndiotactic/* (*/st/*-) and */isotactic/* (*/it/*-) PMMA polymers were prepared and subsequently functionalized to afford nanoparticle ligands. Nanoparticles with complementary */st/*- and */it/*-PMMA ligands could then be spontaneously assembled upon mixing at room temperature. This process was robust and fully reversible through multiple heating and cooling cycles. The versatility of PMMA stereocomplexation was highlighted by assembling hybrid structures composed of nanoparticles of different compositions (e.g., Au and quantum dots) and shapes (e.g., spheres and rods). These initial demonstrations of nanoparticle self-assembly from inexpensive PMMA-based materials present an attractive alternative to DNA-based nanomaterials.

KL-02

UPCONVERSION: ODYSSEY

J. A. Capobianco

Department of Concordia University Chemistry and Biochemistry and Centre for Nanoscience Research, 7141 Sherbrooke St West, Montreal, Quebec H4B 2R1, Canada

The field of upconversion in ion doped system can be traced back to an idea of Bloembergen in 1959. Bloembergen proposed that IR photons could be detected and counted through sequential absorption (ESA) within the levels of a given ion in a solid. Role of energy transfer in upconversion was recognized by Auzel in 1966. Medical science has begun to focus their attention on the use of nanomaterials to improve diagnosis and treatment of diseases with the ultimate goal of moving into personalized medicine. The need to develop more efficient drug delivery procedures motivated us to propose novel nano-carrier based on lanthanide upconverting nanoparticles (UCNPs). They offer significant advantages in biological applications, particularly the extension of the system applicability to deep tissue regions of the body, a reduced scattering of the excitation wavelength, reduction of autofluorescence, and decrease in photodamage to the system under study. We will discuss relevant biological applications of these upconverting nanoparticles as a platform for drug delivery, photodynamic therapy, optogenetic, XPDT and nanothermometry.

KL-03

NATURAL PRODUCT-BASED POLYMERS THAT ADDRESS HEALTH-FOOD-ENERGY-WATER CHALLENGES

K. L. Wooley

Texas A&M University, Departments of Chemistry, Chemical Engineering, and Materials Science & Engineering, College Station, Texas, USA (wooley@tamu.edu, www.chem.tamu.edu/faculty/karen-wooley/, @karen_wooley)

A primary interest in the Wooley laboratory is the production of functional polymers from renewable sources that are capable of reverting to those natural products once their purpose has been served. A long-standing focus has been the development of synthetic methodologies that transform sugars, amino acids and other natural products into polymer materials. This approach allows for the production of functional polymers from renewable sources that are capable of reverting to those natural products once their purpose has been served. This holistic life cycle approach is of importance from the perspectives of sustainable sourcing of materials feedstocks, while creating mechanisms for breakdown of the polymer materials after useful lifetime is complete, and providing for biological and environmental resorption of breakdown products. The overall process impacts the need to address the increasing accumulation and associated hazards of plastic pollution from the environmental persistence of non-degradable, petrochemically-sourced polymer systems. Moreover, inherent diversities of natural products provide opportunities to expand the scopes, complexities and properties of polymers, by utilizing fundamental organic chemistry approaches. This presentation will highlight synthetic strategies for the development of polymers, block polymers and crosslinked network materials, which can be produced by relatively simple approaches from carbohydrates, amino acids and other natural small molecule or macromolecular components, and can be made to exhibit a range of properties. Target materials are designed for potential applications in diverse areas, from energy, to medicine, to the environment. Examples will highlight contributions that polymer chemistry can make toward bulk technological materials that are capable of impacting global needs, such as water-food-energy-health, and the grand challenges that must be solved in the coming decade, while also emphasizing fundamental synthetic chemistry advances.

KL-04

PHARMACOLOGICALLY ACTIVE POLYMER MICELLES FOR NOVEL THERAPEUTICS

Y. Nagasaki

Department of Materials and Medical Science, University of Tsukuba, Tsukuba, Ibaraki 305-8573, Japan
(happyhusband@nagalabo.jp)

At the end of the 19th century, Paul Ehrlich found that methylene blue stains only the nerve endings of rabbits, so he thought, with a suitable choice of molecules, it has no effect on healthy parts of the body and is influenced the disease sites. He called it a “magic bullet” for such drugs. In the 21st century, a molecular-targeted drug was put into practical use, and his idea was realized. By the molecular target drugs, have cancer patients disappeared from the world? The answer is no. In reality, the number of deaths from cancer patients is steadily increasing year by year. In addition to developing further effective molecular-targeted drugs, a new concept of "medicine" is indispensable for reducing patient pain and improving efficacy. The objective of this research is to construct a new modality for the development of novel drugs by a new concept of molecular-assembling medicines following synthetic organic molecules and biomolecular drugs such as antibody drugs and nucleic acid drugs. This concept is based on the observation that self-assembling antioxidants suppressed their adverse effects significantly, accumulated in the inflammation site, and effectively eliminated reactive oxygen species (ROS). Our results indicate that biological functions and therapeutic effects that cannot be obtained with low molecular weight compounds alone can be controlled by organizing small molecules. In recent years, in the field of drug discovery and development, several medicines whose medicinal effects are exerted only by self-assembling (polymer colloid) have been discovered. By developing our proposed research, we would like to achieve a friendly system for patients as a basis for creating an innovative drug discovery industry.

MAIN LECTURES

ML-01

PARTICLE MORPHOLOGY OF POLYMER COLLOIDS. FROM REACTOR TO FILM

J. M. Asua

POLYMAT, University of the Basque Country UPV/EHU, Donostia-San Sebastián, Spain

Polymer colloids are used in applications that involve both high tonnage products (e.g., coatings and adhesives) and very specialized products as carriers for drug delivery and theranostics. The application properties of these materials are determined by multiple characteristics such as copolymer composition, monomer sequence distribution, molar mass distribution, polymer architecture, particle morphology, particle size distribution, and surface chemistry. They are product-by-process materials, namely products that get all their characteristics in the reactor and little can be modified afterwards. Unfortunately, they are produced through processes such as (mini)emulsion polymerization, which are prone to suffer run-to-run irreproducibility. Therefore, there is a strong need of controlling these polymerization processes. Whereas some characteristics such as copolymer composition, molecular weight distribution of linear polymers and in a large extent particle size distribution are currently well controlled, we are far from controlling well other characteristics as polymer architecture of non-linear and crosslinked polymers and particle morphology. The main reason being the impossibility of measuring on-line these characteristics. Particle morphology is particularly critical because waterborne polymer dispersions are most often applied as films, and the application properties depend on how particle morphology is transformed during film formation to determine the film morphology. This lecture will focus on the developments of online control of the particle morphology and on the link between particle morphology and film morphology.

ML-02

GRAFT MODIFICATION OF STARCH NANOPARTICLES VIA NITROXIDE MEDIATED POLYMERIZATION

A. T. Fritz[a], J. C. Cazotti[a], O. Garcia-Valdez[a], M. A Dube[b], N. M. B. Smeets[c], M. F. Cunningham[a]

[a]*Department of Chemical Engineering, Queen's University, Kingston, Ontario K7L 3N6, Canada*
[b]*Chemical and Biological Engineering, Ottawa University, Ottawa, Ontario K1N 6N5, Canada*
[c]*Ecosynthetix Corporation, Burlington, Ontario L7M 1A6, Canada*
(michael.cunningham@queensu.ca, www.cunninghamlab.ca)

Starch is attracting increasing attention as a potential substitute for conventional synthetic, petroleum-based polymers due to its low cost, abundance, and biodegradability. Native starch is hydrophilic with poor mechanical properties, but can be graft copolymerized to improve the physical properties and increase compatibility with hydrophobic polymers. If a suitable improvement in properties and compatibility with synthetic polymers could be achieved, the use of starch in a wide range of commercial applications becomes feasible, including for example paper coatings and water-based adhesives. We have developed a method to custom tailor starch nanoparticles by grafting synthetic polymers to the starch backbone. We established the required chemistry using cold water soluble starch (CWS), which was graft copolymerized using nitroxide mediated polymerization (NMP). Using a similar type of approach, we then adapted to the chemistry to graft synthetic polymer to crosslinked starch nanoparticles. The approach we have developed is highly flexible, allowing modification of the starch with a wide range of different synthetic polymers, and allowing facile tailoring of the graft copolymer design, including for example the number of grafted chains, the molecular weight of the grafted chains, and the incorporation of functional groups to impart desired functionality to the grafted starch.

ML-03

SYNTHESIS OF BIOBASED LATEXES FROM RENEWABLE AROMATIC BUILDING BLOCKS BY (MINI)EMULSION POLYMERIZATIONS

P. Lacroix-Desmazes

Institut Charles Gerhardt Montpellier, CNRS, Univ Montpellier, ENSCM, 1919 route de Mende, 34293Montpellier, France (patrick.lacroix-desmazes@enscm.fr, www.icgm.fr/en/patrick-lacroix-desmazes-en)

The use of petroleum-based resources in waterborne coatings still poses an issue as more stringent environmental regulations are implemented. We present our results using aromatic biobased renewable resources to prepare new biobased monomers in order to overcome the barriers to the sustainable development of polymer materials by aqueous (mini)emulsion radical polymerization (Figure 1), opening up the use of these new building blocks in latex formulations for coatings & pressure-sensitive adhesives.[1-4]

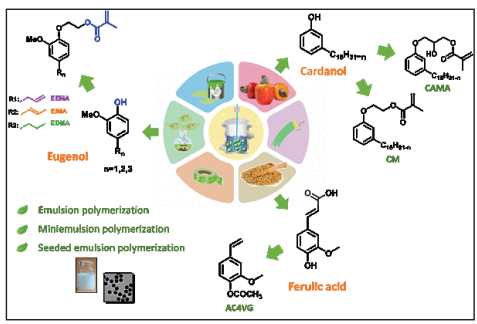

Figure 1. Synthesis of biobased latexes from renewable aromatic building blocks.

Acknowledgement: *PLD thanks all his co-authors and collaborators taking part in the topic of biobased latexes.*

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ML-04

VISIBLE LIGHT-INDUCED PHOTOPOLYMERIZATION IN DISPERSED MEDIA: SYNTHESIS OF CONVENTIONAL AND INORGANIC-ARMORED LATEXES

E. Bourgeat-Lami[a], R. Canterel[a,b], D. Subervie [a,b], M. Schoumacker [a,b], M. Lansalot[a], J. Lalevée[c], E. Lacôte[b]

[a]Univ Lyon, Catalysis, Polymerization, Processes and Materials (CP2M), 43 Bvd. du 11 Nov. 1918, 69616 Villeurbanne, France
[b]Univ Lyon, LHCEP, 2 rue V. Grignard, 69622 Villeurbanne, France
[c]Institut de Science des Matériaux de Mulhouse, 15 rue J. Starcky, 68057 Mulhouse, France

N-Heterocyclic carbene (NHC)-boranes have been found to be efficient co-initiators for the type II photopolymerization of (meth)acrylates using both UV and visible light.[1] Visible light allows a better penetration of light compared to UV-photoinitiation, making it compatible with emulsion polymerization. We report herein a new water-soluble NHC-borane-based system capable of initiating the emulsion photopolymerization of styrene and (meth)acrylic monomers using a simple and cheap equipment composed of a LED ribbon wrapped around a standard double-wall glass reactor. Our system relies on the photoreduction of diphenyl disulfide by visible-light irradiation of acridine orange to generate a thiyl radical that further abstracts a hydrogen atom from the NHC-borane leading to the initiating NHC-boryl radical. The process allows the formation of stable latexes with diameters in the range 50-300 nm, full conversions and solids contents up to 40 wt%.[2,3] The synthesis has been successfully extended to dispersion polymerization conditions in hydroalcoholic media leading to very large particles, demonstrating the high potential of this NHC-borane photo-initiating system. Interestingly, the water-soluble dicarboxylic acid disulfide alone is also capable to initiate the emulsion[3] and dispersion photopolymerization of MMA and MMA/BA mixtures. Taking advantage of the affinity of COOH groups for cerium dioxide (CeO_2) particles, this new disulfide photoinitiator was used to form CeO_2-armored composite colloids in the absence of molecular surfactant. Such Pickering latexes with UV-sensitive nanoceria shell are of valuable interest for the formation of UV-absorbing coatings with enhanced mechanical properties.

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ML-05

RESPONSIVE POLYMERIC NANOCAPSULES AND MULTI-COMPARTMENTS AS CELLULAR MIMICS

B. Voit

Leibniz-Institut für Polymerforschung Dresden e.V., Hoh Strasse 6, D01069 Dresden, Germany
(voit@ipfdd.de)

Polymeric micro- or nanocapsules and multicompartment systems are highly interesting in the field of nanoreactors and in mimicking biological systems and processes. Of special interest is the introduction of a stimuli-responsiveness into the capsule shell to be able to control the traffic of small and larger compounds and particles into and out from the capsule interior. We will report on robust, pH-responsive and multifunctional photocrosslinked polymersomes, which are interesting for studies in synthetic biology, but also for application as nanoreactors in microsystem devices and in nanotechnology. While pH sensitive polymersomes usually disassemble upon acidification, ours show a definite swelling, since the cross-linked membrane remains intact, and they allow pH-dependent diffusion of small molecules through the membrane. Thus, cascade enzyme reactions could be carried out under pH control using polymersome-encapsulated enzymes and specific features of organelles could be mimicked. In such pH-responsive and photo-crosslinked polymersomes various function can be integrated e.g. additional light or redox responsiveness, and they can be decorated with various functionalities and bioactive biomacromolecules to achieve specific binding properties, targeting or therapeutic action. Larger proteinosomes (up to 50 micrometer), prepared by pickering emulsion from BSA-PNIPAAm bioconjugates, have been realized as synthetic cell wall, and those compartments have been equipped with the smaller pH-responsive polymersomes, mimicking organelle structures in a cell. Examples will be given how these multicompartments can be used to study complex cellular functions controlling cellular traffic.[1,2]

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ML-06

COLLOIDAL SYSTEMS FOR THE FABRICATION OF CELL MIMICS AND PROTOCELLS

D. Appelhans[a], P. Wen[a,b], X. Wang[a], P. Wang[a], S. Moreno[a], X. Huang[b], B. Voit[a]

[a]Leibniz-Institut für Polymerforschung Dresden e. V., Hohe Sraße 6, 01069 Dresden, Germany
[b]Harbin Institute of Technology, Harbin 150001, China
(applhans@ipfdd.de)

Engineering of multifunctional vesicular (multi)compartments for mimicking specific cellular functions and protocells is one promising approach for overcoming protein lack in organ tissues and human diseases as well as for imitating prebiotic live.[1,2] The vesicular compartments have to fulfill various key characteristics (e.g. tuneable by external stimuli (e.g. light and redox), controlling membrane functions for exchanging biomolecules, controlled release of biomolecules, retaining cargo inside of vesicular cavity),[3-6] while multicompartments[7] should also possess orthogonal-responsive membrane properties to control spatiotemporal and spatially separated biological pathways for establishing protocells. Overall, this would result in, for example, the establishment of next-generation therapeutics, life-like cells and bio-nanotechnology approaches. This contribution will show the fabrication of pH-responsive polymersome-based hollow capsules[7] and proteinososomes. It will also highlight the common integration of biologically-active particles in microgel and polymersome compartments within proteinosomes, including the controlled action of enzymes, for the establishment of protocells besides the use of enzyme-loaded polymersomes as artificial organelles.

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ML-07

MULTIBLOCK COPOLYMER SYNTHESIS AND NANOPARTICLE ENGINEERING USING RAFT EMULSION POLYMERIZATION

P. B. Zetterlund[a], T. R. Guimarães[a], M. Khan[a], G. K. K. Clothier[a], S. W. Thompson[a], G. Moad[b], S. Perrier[c]

[a]Cluster for Advanced Macromolecular Design (CAMD), School of Chemical Engineering, University of New South Wales, Sydney, NSW 2052, Australia
[b]CSIRO Manufacturing, Bag 10, Clayton South, VIC 3169, Australia
[c]Department of Chemistry, University of Warwick, Coventry, CV4 7AL, UK
(p.zetterlund@unsw.edu.au)

Multiblock copolymers composed of polymer segments of sufficiently high molecular weight such that microphase separation and self-assembly can occur provide a pathway to a myriad of nano-engineered materials. We have focused on synthesis of multiblock copolymer nanoparticles in environmentally friendly aqueous emulsion polymerization based on reversible addition-fragmentation chain transfer (RAFT) polymerization using the three most commonly industrially employed monomer families in emulsion polymerization, namely methacrylates, acrylates and styrene.[1,2,3] Due to the submicron-size of the polymeric nanoparticles that form the locus of polymerization, the polymerization can proceed at a significantly higher rate than the corresponding homogeneous (solution, bulk) system. Exploitation of such compartmentalization effects enables access to polymer structures that are challenging to prepare under homogeneous polymerization conditions, especially using slowly propagating monomers such as methacrylates. The method developed is environmentally friendly (use of water as solvent) and fulfils all requirements for scale up to an industrial process.

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ML-08

COPOLYMERS WITH PH-SENSITIVE POLYPEPTIDE BLOCK: SYNTHESIS AND SELF-ASSEMBLY INTO POLYMERSOMES

E. Aydinlioglu, G. Le Fer, E. Ibarboure, C. Bonduelle, O. Sandre, S. Lecommandoux

Laboratory of Organic Polymer Chemistry CNRS, Univ Bordeaux, France (olivier.sandre@u-bordeaux.fr, www.lcpo.fr)

Synthetic proteins or polypeptides are ideal biocompatible building blocks to engineer polymer nanoparticles for drug or gene delivery applications.[1] In this work, different block copolymers were synthesized by ring opening copolymerization of several α-aminoacid *N*-carboxyanhydrides (NCA) using PEO-NH_2 chains (of either 2 or 5 kD molar mass) as macroinitiators. Hydrophobicity was brought by the NCA of *L*-phenylalamine (Phe), which was copolymerized with the NCA of either γ-benzyl-*L*-glutamate which turns into *L*-glutamic acid (Glu) after deprotection, or with *L*-lysine (Lys). These peptides exhibit a secondary structure transition when pH is changed across their pKa which varied on the Phe-content, respectively between 5.3 and 6.1 for the Glu-*co*-Phe copolymers, or 9 and 10 for the Lys-*co*-Phe ones (Fig 1). Firstly, PEO-*b*-P(Glu-*co*-Phe) batches of different hydrophilic fractions were self-assembled in water by direct dissolution, rehydration or nanoprecipitation. Preliminary encapsulation, release and cytotoxicity tests with curcumin as model drug are reported. In a second part, $PEO_{46/114}$-*b*- $P(Glu_{100/60}$-*co*-$Phe_{65/40})$ and $PEO_{46/114}$-*b*-$P(Lys_{100/60}$-*co*-$Phe_{65/40})$ chains were co-assembled to form polyionic complexes (PIC) near charge equilibrium, leading to vesicle structures as shown by AFM and TEM. Preliminary tests of siRNA loading in PICsomes showed higher efficacy than free siRNA.

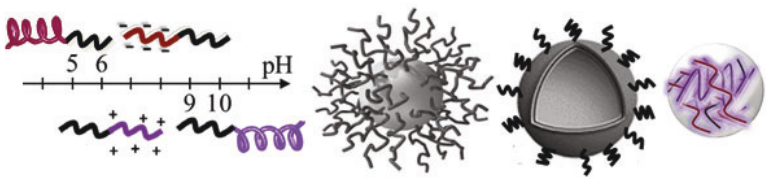

Figure 1. Secondary structure transition of the polypeptide blocks and the different morphologies obtained by self-assembly or co-assembly: polymer micelles, vesicles or polyionic complexes.

Acknowledgement: *EU H2020 MSCA-ITN-2015-ETN grant No. 676137 NANOMED.*

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ML-09

SUPRACOLLOIDAL CHEMICAL ENGINEERING: TOWARDS "GREENER POLYMER AND COLLOID BASED MATERIALS AND PRODUCTS

S. A. F. Bon, S. R. Wilson-Whitford, J. R. Booth, B. W. Longbottom, E. Brogden

Department of Chemistry, The University of Warwick, Coventry, CV4 7AL, United Kingdom
(https://bonlab.info)

In this talk we will highlight some of the latest scientific developments from our lab.
(1) We will discuss the concept of interfacial crystallization as a viable route to fabricate textured microcapsules, as alternative to polyurethane/polyurea capsule technology. We will show that these surface roughened capsules have a bonus added feature in that they show enhanced deposition onto a range of fabric fibres.
(2) We will look at the fabrication of a prototype for an electricity-free thermoresponsive icy road sign that relies on the concepts of an upper critical solution temperature phase transition of a polymer solution in combination with aggregation induced emission of a fluorescent co-monomer.
(3) We will briefly address the use of anisotropic rodlike silica particles as building blocks for opacifying films and light scattering supracolloidal microspheres, as alternative to titanium dioxide based technology.
(4) We will discuss our journey on how we developed a liner-less waterborne pressure sensitive adhesive for consumer good labels.

ML-10

PREPARATION OF NON-SPHERICAL POLYMER PARTICLES BY MECHANICAL PROCESS

H. Minami

Graduate School of Engineering, Kobe University, 1-1 Rokko Nada, Kobe 657-8501, Japan
(minamihi@kobe-u.ac.jp, www.research.kobe-u.ac.jp/eng-cx6/)

Generally, polymeric particles prepared in a heterogeneous polymerization system tend to become spherical in shape as the interfacial free energy between particles and medium is minimized. Unlike spherical particles, non-spherical particles usually have some additional properties including rheological, optical, and mechanical properties.

Recently, we have reported an effective and facile strategy to prepare cylindrical polystyrene (PS) particles simply by stirring using a magnetic stirrer in an aqueous polyvinyl pyrrolidone solution.[1,2] However, the details of the particle deformation remain unclear. In this presentation, the mechanism of deformation to cylindrical shape will be clrified, and we also demonstrate a facile preparation method of the disc-like (composite) polymer particles by a mechanical process using a planetary bead mill (Figure 1). The relationship between the relative sizes of ZrO_2 bead/PS particle and the degree of deformation of the particles was clarified, which indicated the size of the discs could be controlled.

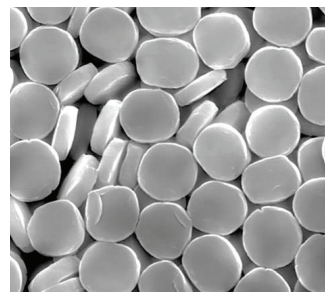

Figure 1. SEM image of PS particles after milling with 100 μm-sized ZrO_2 beads for 12 h at *r.t.*

Keywords: Non-spherical shape, Mechanical stress.

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ML-11

SPONGE LIKE BIODEGRADABLE MICROPARTICLES FOR COSMETO-THERAPY TEXTILE

N. Zafar, A. Elaissari

Univ Lyon, University Claude Bernard Lyon-1, CNRS, ISA-UMR 5280, 69622 Villeurbanne, France

Broadly speaking, two of the most important applications of textiles include their delivery of cosmetic and therapeutic agents. A cosmetotextile is a material containing a cosmetic preparation primarily for dermatology application such as moisturizing, slimming or antistretch mark. Textiles have been used in medical field since long time and they find applications in medical sutures, gauzes, bandages and repair fabrics and artificial aortas. However, the concept of their usage for drug delivery was not matured until the end of last millennium. Transdermal drug delivery is sought for a number of reasons. Certain actives, upon oral delivery, get absorbed in stomach or intestinal tract and on metabolism lose their activity before reaching their target organs. In such cases, dermal drug delivery is preferred to avoid the requirement of higher doses and toxicity risk associated with such higher doses. Moreover, in specific patients e.g. children, elderly patients or patients in coma, where drug compliance is relatively low because of forgetfulness or difficulty in swallowing of medications, the drug compliance can be enhanced by dermal drug delivery which requires less frequent dosing.

The objective of this work was to prepare and characterize biodegradable, cationic and sponge like multifunctional microparticles that can be used not only for the delivery of cosmetic and therapeutic agent (anti-inflammatory) but can also be potentially applied onto specifically selected textile for their functionalization. For achieving these goals, polymethylmethacrylate based microparticles were prepared using double emulsion-diffusion solvent evaporation technique. Systematic studies were performed for optimization of process control parameters. Once desired size of sponge like particles was obtained from the systematic study, the polyamide textile surface was functionalized with these particles while dedicating special attention to electrokinetic properties of textile as a function of various parameters such as; particles amount present during adsorption process. Finally, encapsulation of pure vitamin E, Lauryl Isoquinolinium Bromide (LIB), Indomethacin (IMC) as well as encapsulation of complexes of Vit E-Hydroxypropyl-beta-cyclodextrin (HPβCD), LIB-HPβCD and IMC-HPβCD into microparticles was done separately. These particles were characterized for encapsulation efficiency and skin penetration.

Acknowledgement: *Results from Texactive project (Nadiah Zafar thesis).*

ML-12

POLYMER COLLOIDS INTERACTING WITH PROTEINS

W. Malicka, J. J. Walkowiak, M. Ballauff

Institute of Chemistry and Biochemistry, FU Berlin, Takustrasse 3, 14195 Berlin, Germany
(matthias.ballauff@fu-berlin.de)

Proteins may bind strongly to colloidal particles in solution. In my lecture I'll present our recent work in this field where we studied the interaction of proteins with spherical polyelectrolytes in aqueous solution. The SPBs are composed of a solid polystyrene core bearing long chains of poly(acrylic acid). Isothermal titration calorimetry (ITC) done at different temperatures and ionic strengths is used to determine the binding constant of the proteins to the SPB. This analysis leads to a full set of thermodynamic binding constants together with the enthalpies and entropies of binding. In general, we find that the free energy of binding ΔG_b depends only weakly on temperature because of a marked compensation of enthalpy by entropy. The quantitative analysis demonstrates that counterion release is the major driving force for binding where proteins become multivalent counterions of the polyelectrolyte chains upon adsorption. The release of water molecules during complex formation, on the other hand, is shown to be of minor importance. We discuss the significance of these findings for biomedical applications of colloidal particles in drug delivery.

ML-13

HYDROPHILIC PROLATE SPHEROIDS: PREPARATION, PROPERTIES AND FORMATION OF STRUCTURED MATERIALS

T. Basinska[a], D. Mickiewicz[a], M. Gadzinowski[a], T. Makowski[a], W. Szymański[b], S. Slomkowski[a]

[a]Centre of Molecular and Macromolecular Studies, Polish Academy of Sciences, H. Sienkiewicza 112, 90-363 Lodz, Poland
[b]Technical University of Lodz, Institute of Materials Science and Engineering, B. Stefanowskiego 1/15, 90-924 Lodz, Poland
(basinska@cbmm.lodz.pl)

Spherical particles are among the widely used building blocks and their self-arrangements are limited to hexagonal symmetries. Relatively little is known about formation of self-arrangements of particles with shape anisotropy. In order to fill a gap we underwent the studies of preparation and organization polymer prolate spheroids on solid supports. The prolate spheroidal particles were prepared from the synthesized very uniform hydrophilic polyglycidol containing shell and polystyrene core microspheres (PS/PGl_m) with D_n=400 nm. The PS/PGl_s spheroids were obtained by elongation of corresponding microspheres embedded in poly(vinyl alcohol) (PVA) film in controlled conditions, above T_g of all polymeric ingredients of which particles and film were made. The aspect ratio (AR) of PS/PGl_s spheroids in the range 2-8 was proportional to the length of the film elongation. The PS/PGl_s particles were characterized by SEM, XPS, elemental analysis and electrophoretic mobility measurements. It was found that PVA film elongation process affected the spheroids polystyrene-polyglycidol domains surface which was rearranged and covered by PVA chains indelible by washing with water. The SEM images of particles 2D and 3D self-assemblies shown that the hydrophilic prolate spheroids formed colloid crystalline arrays resembling ordering in nematic liquid crystals. In addition, the spatial assembling of 3D spheroidal arrays and spheroids aspect ratio affected their optical and mechanical properties.

Acknowledgement: *The authors express their gratitude for financial support from National Science Centre (Poland) grant Nr UMO-2018/29/B/ST8/01721.*

ML-14

COOL COATINGS; APPLICATION OF CORE-SHELL LATEX PARTICLES IN FUNCTIONAL COATINGS

A. M. van Herk[a], S. Jana[b], P. Thoniyot[b]

[a]*Eindhoven University of Technology, The Netherlands*
[b]*Institute for Chemical and Engineering Sciences, Singapore*
(a.m.v.herk@tue.nl)

New developments in coatings for buildings often rely on nanotechnology developments. Properties like hiding power, colour and even total solar reflectance (for cool coatings) depend on the level of dispersion, spacing and location of the nanoparticles. A relatively unexplored option is to coat the pigment particles with polymer to force a minimum spacing of the particles.[1] Surface properties like dirt pick-up of the coatings film depend on surface tension and surface roughness. Creating hydrophobic surfaces by utilization of fluorinated polymers seems like an expensive option, again through utilization of nanotechnology the amount of expensive fluorinated polymer can be minimized still obtaining the desired effects.[2]
Water-based coatings still need plasticizers to facilitate film-formation, these compounds contribute to VOC. A fully plasticizer free water-based coatings formulation has been developed through the use of the nanoconfinement effect where interactions between inorganic particulates and the binder polymer can create a so-called glass transition temperature jump, effectively eliminating the need for a plasticizer.[3,4]
In all these coatings applications the structure of the nanoparticles and the interactions between interfaces are of paramount importance.

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ML-15

ACRYLIC POLYMER DISPERSIONS – FROM COLLOIDAL STRUCTURE TO APPLICATION PROPERTIES

B. Reck, I. Willerich, C. Auschra

BASF SE, Research & Development Dispersions and Resins, Carl-Bosch-Strasse 38, D-67056 Ludwigshafen, Germany (bernd.reck@basf.com, www.basf.com)

Film forming acrylic polymer dispersions are widely used as binders for architectural and decorative coatings for many substrates. Many of their application properties are determined by the hydrophilic surface layer, which is formed at the latex particle surface during the emulsion polymerization process.[1] In this presentation, we will illustrate such structure-property correlations for selected examples of acrylic polymer dispersions.

Colloidal stability of polymer dispersions, e.g. against the destabilizing effect of added salts, is greatly improved by the presence of a hairy layer formed by hydrophilic comonomers like acrylic acid or acrylamide.[2] The hairy layer size correlates also with the effective volume fraction of the latex and its viscosity for a given solids content.[3]

Last but not least, the hydrophilic latex surface layer is playing a key role in the interaction of polymer dispersions with formulation additives like e.g. thickeners and TiO_2 piments. Thus, the interaction of the latex particles with associative thickeners is important for achieving the desired paint rheology.[4] The opacity and the hiding power of a paint strongly depend on the optimum interaction between latex particles and TiO_2 pigment particles. Theses interactions have been characterized by advanced methods like Analytical Ultracentrifuge and Confocal Laser Scanning Microscopy.[5]

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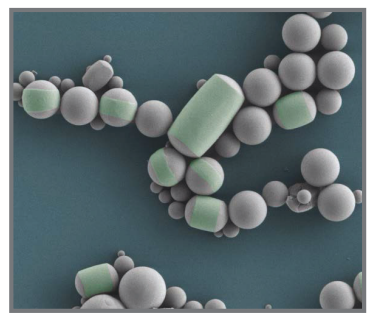
ML-16

PATIENCE IS A VIRTUE IN THE DESIGN OF ANISOTROPIC PARTICLE MORPHOLOGY

J. G. Tsavalas[a,b], A. K. Tripathi[a,b]

[a]*Department of Chemistry, University of New Hampshire, Durham, New Hampshire 03824, United States*
[b]*Materials Science Program, University of New Hampshire, Durham, New Hampshire 03824, United States*
(john.tsavalas@unh.edu)

Contrary to most approaches leveraging plasticization to manipulate polymeric microparticles into aspherical morphologies, we demonstrate here a rather facile process toward a uniform conversion of spheres to spherocylinders specifically under glassy conditions. Moreover, as a result of leveraging plastic deformation, the spherocylindrical form contains a microcavity suited to optical applications or loading of the capsules with payload. The spherocylindrical morphology also matches with sought after models for low Reynolds number flow shapes commonly observed with swimming bacterium – this shape has promise for a wide variety of materials applications. A surprising advantage in this approach is that this well-defined morphological transition results from glassy plastic deformation at room temperature and merely as a result of imposing shear to orient the particles in the dispersion via mild stirring – very accessible and inexpensive process conditions. No special plasticizer is necessary, and in fact when plasticization was present the morphology was lost with a reversion back to the lower energy spherical state. While conditions shown here required circa 120 hours for complete conversion, the time necessary and the characteristics of the internal cavity are able to be modulated by primary particle size, hydrodynamic flow conditions, and the balance between particle and continuous phase viscosity.



ML-17

LIGHT SCATTERING FOR STRUCTURAL STUDIES OF COLLOIDAL MATERIALS

S. Podzimek[a,b,c]

[a]*Wyatt Technology, D-56307 Dernbach, Germany*
[b]*SYNPO, 532 07 Pardubice, Czech Republic*
[c]*Faculty of Chemical Technology, 532 10 Pardubice, Czech Republic*

Two types of light scattering can be used to study various colloidal systems: they are static (Rayleigh) light scattering and dynamic light scattering.[1,2] The latter gained wide popularity due to its simplicity, yet it is used mainly in a batch mode to characterize the size of colloidal particles. The former type of light scattering is capable of bringing the most detailed information about the molecular structure of soluble colloidal materials, polymers prepared by emulsion polymerization being typical examples. The static light scattering photometer, mostly called multi-angle light scattering (MALS) detector, is typically used in combination with an analytical separation technique, either size exclusion chromatography (SEC) or asymmetric flow field flow fractionation (AF4).[2] Although SEC is well known and widely used, it is often unable to provide true molar mass information when used in its conventional form with column calibration. Coupling SEC with a MALS detector not only yields absolute molar mass distribution, but can provide information about molecular structure and also reveal failure of SEC to efficiently characterize large polymer molecules. Due to the lack of stationary phase, AF4 offers several advantages that are especially valuable in the area of very large colloidal molecules and supermolecular structures such as nanogels.

The contribution brings a short overview of basic principles of AF4 and MALS and several examples of the use of SEC-MALS and AF4-MALS for the characterization of molecular structure of colloidal materials with the focus on molecular structure of acrylic emulsion copolymers.

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NOTES

SPECIAL LECTURES

SL-01

DESIGN OF BIOBASED (CO)POLYMERS AND NANOPARTICLES THROUGH EMULSION/DISPERSION POLYMERIZATION OF BIOSOURCED MONOMERS IN GREEN SOLVENT

M. Balarezo, F. Coumes, F. Stoffelbach

Polymer Chemistry team (ECP), Parisian Institute of Molecular Chemistry (IPCM), Sorbonne University, Campus Pierre et Marie Curie
4 Place Jussieu, 75005 Paris
(mauricio.balarezo_mosquera@sorbonne-universite.fr)

We combined the Polymerization Induced-Self-Assembly (PISA) technique and the Reversible Addition-Fragmentation chain Transfer (RAFT) radical polymerization to engineered nanoparticles (NPs) based on new **biobased amphiphilic copolymers**. While the RAFT polymerization allows the preparation of well-defined polymers,[1] the PISA approach, proceeding in heterogeneous and potentially "green" conditions, leads to the formation of amphiphilic block copolymers that self-assemble into self-stabilized nanoparticles (NPs), avoiding the use of any free surfactant.[2] In this work, a **hydrophilic biobased** reactive block, namely a macro-RAFT agent, was used in the PISA approach of **hydrophobic biobased monomers** to generate **biosourced NPs in green solvent**. The polymerization conditions were varied (molar mass of macro-RAFT, targeted DP, pH) to achieve the *in-situ* formation of stable NPs (Figure 1).

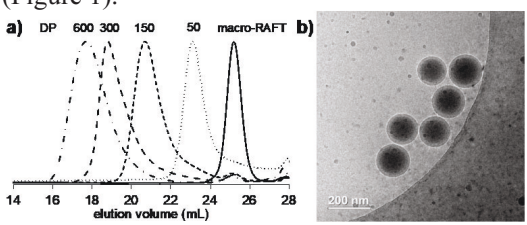

Figure 1. a) Size exclusion chromatography profiles (in THF), b) Cryogenic transmission electron microscopy image of NPs in water (targeted DP of the hydrophobic block: 600).

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SL-02

DESIGN OF NEW MACROMOLECULAR STABILIZERS INCORPORATING VINYL ALCOHOL UNITS FOR THE EMULSION (CO)POLYMERIZATION OF VINYL ACETATE

M. Raffin[a], T. Melchin[b], M. Lansalot[a], F. D'Agosto[a]

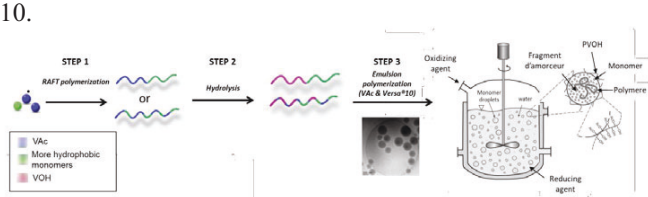
[a]*Univ Lyon, Université Claude Bernard Lyon 1, CPE Lyon, CNRS, UMR 5128, Catalysis, Polymerization, Processes and Materials (CP2M), 69616 Villeurbanne, France*

[b]*Wacker Chemie AG, Johannes-Hess-Straße 24 84489 Burghausen, Germany*

(marie.raffin@univ-lyon1.fr)

Poly(vinyl alcohol-*co*-vinyl acetate) (PVOH) copolymers are used in a wide range of application, including as macro stabilizer for emulsion polymerizations. However, during the emulsion process, free PVOH chains can be found in the aqueous phase[3] and negatively impact the final properties of the latex. The aim of the present project is to synthesize alternative amphiphilic copolymers, that are able to circumvent the potential problems resulting from remaining water-soluble chains encountered in the industrial process.

The synthesis of the targeted amphiphilic copolymers relies on reversible addition-fragmentation chain transfer (RAFT) polymerization that allows the formation of well-defined polymer architectures.[4] A careful design of copolymers of VAc and vinylic ester comonomers (CoM) was first performed to access a range of copolymers structures, including block copolymers. CoM, vinyl neodecanoate (VERSA® 10) and vinyl laurate (VERSA® 12) were chosen and hydrolysis conditions that could be selective of the VAc units were identified. After hydrolysis, the resulting well-defined amphiphilic copolymer structures were evaluated as stabilizers in the emulsion copolymerization of VAc and VERSA® 10.



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SL-03

MICROFLUIDIC FORMATION OF MULTILAYER MICROCAPSULES BY SEQUENTIAL LIQUID–LIQUID PHASE SEPARATION

T. Watanabe, Y. Yasuhara, T. Ono

Department of Applied Chemistry, Graduate School of Natural Science and Technology, Okayama University, 3-1-1, Tsushima-naka, Kita-ku, Okayama, 700-8530, Japan
(wata-t@okayama-u.ac.jp, http://achem.okayama-u.ac.jp/interface/en/)

Microcapsules with multilayer structures can be prepared with complex droplets as a template. However, it is generally difficult to prepare complex droplets because the preparation requires time-consuming multistep emulsification process while keeping the droplet stability. In this study, we present a rapid microfluidic process to prepare multilayer polymer microcapsules by sequential liquid–liquid phase separation of ternary emulsion droplets followed by photopolymerization of the monomer-rich phases.[1] In this process, the ternary droplet consists of hydrophobic monomer, water, and co-solvent and the co-solvent diffuses into the continuous phase when the droplet flows in the microchannel.[2] The diffusion of the co-solvent induces sequential liquid–liquid phase separation between monomer-rich phase and water-rich phase, eventually leading to high-order emulsion droplet in tens seconds after initial droplet formation. It was found that the number of droplet layer can be tuned from single to quintuple layers by changing the initial ternary phase compositions and that subsequent photopolymerization of the monomer-rich phase results in microcapsules with multilayer structures. We believe that this process can pave the way for the design of colloidal polymer materials with thermodynamically non-equilibrium structures, thereby extending their application in functional materials.

Acknowledgement: *This work was financially supported by the JSPS KAKENHI (grant no. JP21K04749).*

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SL-04

PHASE SEPARATION AND PH-DEPENDENT BEHAVIOR OF STAR-SHAPED PORPHYRIN-PNIPAM$_4$ CONJUGATES

J. Labuta[a], N. Velychkivska[a,b]

[a]*International Center for Materials Nanoarchitectonics (WPI-MANA), National Institute for Materials Science (NIMS), Tsukuba, Japan*
[b]*Institute of Macromolecular Chemistry, Czech Academy of Sciences, Heyrovského nám. 2, 162 06 Prague 6, Czech Republic*
(Labuta.Jan@nims.go.jp)

Star-shaped porphyrin-PNIPAM$_4$ (**PP**) conjugates with four PNIPAM arms connected to a central porphyrin unit were synthesized using RAFT polymerization[1] (Figure 1a). Temperature-induced phase separation (Figure 1b,c) behavior of **PP** was investigated, and the LCST (type II) phase diagram was constructed using Flory−Huggins theory. Below phase-separation temperature (T_p), **PP** behaves as a 1D supramolecular polymer with a concentration-dependent length, while above T_p, **PP** globules adopt a larger spherical shape (Figure 1b). Various temperature−pH reversible and irreversible interdependencies ("cross-effects") between phase separation and protonation were observed by NMR,[2,3] DSC, SAXS, DLS and UV-Vis.

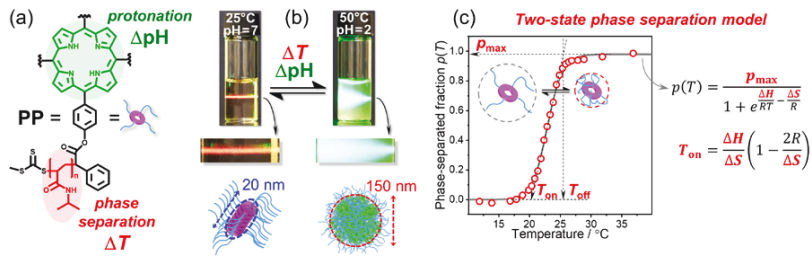

Figure 1. (a) Structure of **PP** (only one arm is shown). (b) Illustration of temperature (ΔT) or pH (ΔpH) change on an aqueous solution of **PP**. Vials are irradiated with a green laser pointer (532 nm). (c) Two-state model of phase separation[2,3] fitted to NMR data.

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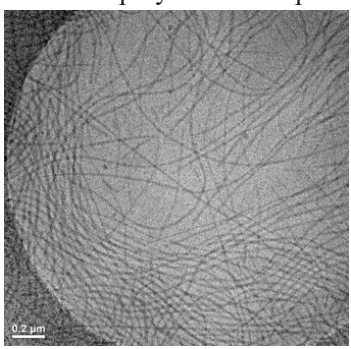
SL-05

EXPLORING THE SYNTHESIS OF POLYMERIC NANOFIBERS BY TEMPLATED POLYMERIZATION-INDUCED SELF-ASSEMBLY

D. Le, G. Mellot, L. Bouteiller, F. Stoffelbach, J. Rieger

Institut Parisien de Chimie Moléculaire (IPCM), Sorbonne Université & CNRS, Polymer Chemistry Team, 4 Place Jussieu, 75005 Paris, France (jutta.rieger@sorbonne-universite.fr, www.ipcm.fr)

Polymerization-induced self-assembly (PISA) has proved to be a very powerful and efficient process to generate various particle morphologies (spheres, worms/nanofibers, vesicles etc.) directly in water.[1] Because of their numerous applications in materials science,[2] nanofibers are particularly interesting structures to be developed. However, these highly anisotropic morphologies are hard to be obtained, and for a selected diblock copolymer the experimental window in which nanofibers can be produced is generally very small. To overcome these limitations, we have shown that the introduction of a hydrogen-bonded bis-urea sticker in the hydrophilic macro-RAFT agent promotes the formation of nanofibers (see Figure) in classical PISA conditions: long nanofibers can be produced in water, in batch conditions and up to 25 wt% solids.[3] Furthermore, it was possible to tune the diameter of the nanofibers by adjusting the length of the hydrophobic polymer block. We will discuss our most recent results in this topic, which include a better understanding of the mechanism and the use of the nanofibers for the stabilization of emulsions.



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SL-06

ARE UNIMER EXCHANGES NECESSARY TO FORM HIGHER ORDER MORPHOLOGIES IN PISA?

C. Debrie[a], N. Coudert[b], T. Nicolai[b], O. Colombani[b], F. Stoffelbach[a], J. Rieger[a]

[a]*Institut Parisien de Chimie Moléculaire (IPCM), Polymer Chemistry Team, Sorbonne Université, 4 place Jussieu, 75005 Paris, France*
[b]*Institut des Molécules et Matériaux du Mans (IMMM), Le Mans Université, Avenue Olivier Messiaen, 72085 Le Mans Cedex 9, France (clement.debrie@sorbonne-universite.fr)*

When Polymerization Induced Self-Assembly (PISA)[1] occurs in aqueous medium, a hydrophobic polymer block (block B) grows from a hydrophilic one (block A). During the synthesis, the produced amphiphilic diblock copolymer self-assembles into nano-objects whose morphology is in principle defined by thermodynamics. The expected evolution of the self-assemblies from spheres to fibers and eventually vesicles[2] when the length of the B block increases is however not always observed in PISA, pointing out the importance of kinetic aspects. The morphological transitions might occur through fusion/fission of nano-objects and/or through polymer chain exchanges between hydrophobic cores.[3] We therefore measured by rheology the unimer exchange dynamics of a comparable polymer, in order to assess whether a kinetically frozen system, *i.e.* with slow unimer exchanges compared to the polymerization duration, can nevertheless evolve towards higher order morphologies. We then studied the impact of several parameters on the kinetic of the transitions.

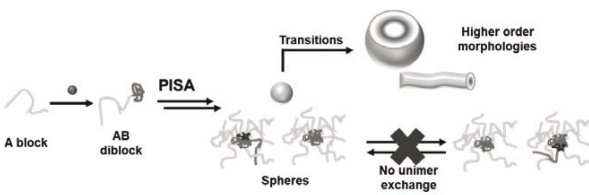

Figure 1. Schematic representation of a PISA synthesis. The obtained AB diblocks were kinetically frozen but still led to fibers and vesicles.

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SL-07

POLYMERIZATION-INDUCED ASSEMBLY OF POLYELECTROLYTES AND COLLOIDAL PARTICLES

B. van Ravensteijn[a,b], C. Li[b], J. Magana[b], I. Voets[b], T. Vermonden[a]

[a]*Department of Pharmaceutics, Utrecht Institute for Pharmaceutical Sciences, Faculty of Science, Utrecht University, P.O. Box 80082, 3508 TB, Utrecht, The Netherlands*

[b]*Institute for Complex Molecular Systems, Department of Chemical Engineering & Chemistry, Eindhoven University of Technology, P.O. Box 513, 5600 MB, Eindhoven, The Netherlands*

The assembly of macromolecular and colloidal building blocks has proven to be a versatile route toward a variety of superstructures. Although typically designed to give one particular equilibrium structure, structural diversity can in principle be realized by walking along different assembly pathways and trapping out-of-equilibrium structures along the way. Here, we introduce two synthetic approaches to control assembly pathways on macromolecular and colloidal length scales.

The first example focuses on the formation of polyion core (PIC) micelles *via* polymerization-induced electrostatic self-assembly (PIESA) using switchable templates. As in conventional PIESA reactions, charged monomers are polymerized from a charge-neutral macro-initiator in the presence of a polyelectrolyte template with opposite charge. As polymerization proceeds morphological transitions of the forming PICs are observed. By introducing templates with switchable charge densities, further control over the assembly pathway can be achieved by modulating the interactions between the macromolecular species on demand.

The second system we are currently developing relies on colloids that assemble under the influence of time-dependent attractive depletion forces. These forces are generated by *in situ* formation of polymer chains in a colloid containing medium. The formed polymers impose an osmotic pressure onto the colloids, which drives their assembly. The strength and range of the generated attractions depend on the size of the polymer coils and hence on the polymerization time. As the system continuously evolves, non-equilibrium structures should arise. By tuning the polymerization kinetics and coil size, structural control via pathway modulation is anticipated.

SL-08

CYCLIC POLYETHYLENE GLYCOL AS GOLD NANOPARTICLE SURFACE LIGAND: SYNTHESIS AND COLLOIDAL STABILITY

M. A. Aboudzadeh[a,b], M. Grzelczak[b], F. Barroso-Bujans[b]

[a]*Universite de Pau et des Pays de l'Adour, E2S UPPA, CNRS, IPREM, Pau, France*

[b]*Materials Physics Center, CSIC-UPV/EHU, Paseo Manuel Lardizábal 5, 20018 Donostia–San Sebastián, Spain*

(m.aboudzadeh-barihi@univ-pau.fr)

Particular polymer topologies such as cyclic ones, have been shown to alter significantly the properties of diverse polymer preparations in both bulk and solutions, when compared to their linear counterparts. On the other hand, gold nanoparticles (AuNPs) continue to attract attention across a wide range of fields due to their optical properties and biocompatibility. In this work, we explore the possibility of applying cyclic polyethylene oxide (PEO) on AuNPs, to study how this polymer topology might affect the colloidal stability. The exchange of citrate ligand (used in the synthesis of AuNPs) with thiol functional group of cyclic PEO allowed to form a strong covalent bond with the gold surface. Thiolated cyclic polymers were obtained by performing copper-catalyzed alkyne–azide cycloaddition between a PEO bis(azide) of M_n= 2, 6 or 11 kg/mol and a previously synthesized thiolated di-alkyne molecule. Purity and mono-dispersity of synthesized cyclic polymer were confirmed by MALDI-ToF MS, NMR and SEC techniques.[1] UV-Vis spectrscopy confirmed the ligand exchange between cyclic PEO and AuNPs. Finally, we found out that cyclic PEO chains could improve the colloidal stability of AuNPs (in comparison to linear ones) at higher ionic strength and elevated temperature.[2]

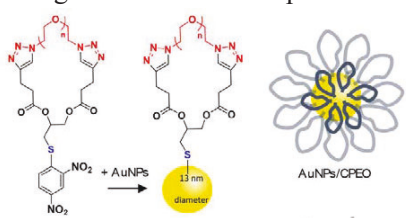

Figure 1. Synthesized AuNP@CPEO samples by ligand exchange of AuNP@citrate against cyclic PEO samples

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SL-09

POLY(THIOL-ENES) THROUGH COLLOIDAL TEMPLATING

P. Krajnc, S. Kramer, V. Hobiger, M. Paljevac

University of Maribor, Faculty of Chemistry and Chemical Engineering, PolyOrgLab, Smetanova 17, 2000 Maribor, Slovenia

Radically induced thiol-ene reaction can be used for the preparation of a variety of poly(thiol-enes) with tailored properties. On the other hand, colloidal templating, such as high internal phase emulsions and combinations of emulsion templating with hard sphere templating, can bring new possibilities of preparing polymers with tailored porosities. Usually, chain polymerisation is used within emulsion templating while thiol-ene step growth and combination of step growth and chain polymerisation will be discussed here. Hydrophilic porous poly(thiol-enes) via oil-in-water and super porous micro particles prepared via a multiple emulsion approach will be presented. Furthermore, a combination of emulsion and hard sphere templating can result in poly(thiol-enes) with hierarchically porous structure.

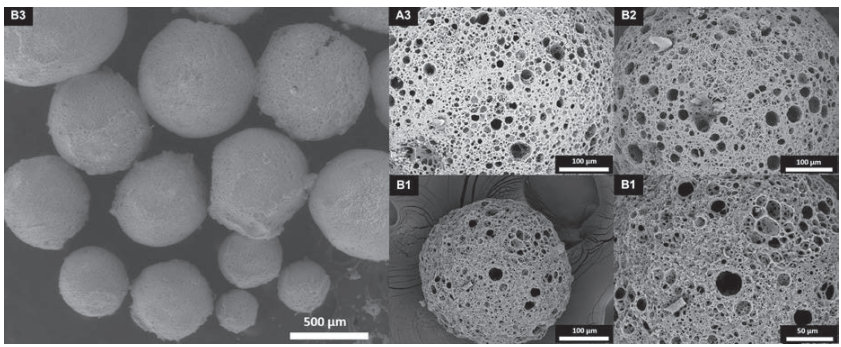

Figure 1. Scanning electron micrograph of poly(thiol-ene) particles prepared by a multiple colloidal templating approach

SL-10

SELF-ASSEMBLY OF AMPHIPHILIC BLOCK-RANDOM COPOLYMERS IN AQUEOUS SOLUTIONS

S. Smeltzer[a], C. Sanders[a], S. George[b], A. Gernandt[c], B. Reck[c], M. F. Cunningham[a]

[a]Department of Chemical Engineering, Queen's University, Kingston, Ontario, Canada
[b]BASF Corporation, Charlotte, North Carolina, USA
[c]BASF SE, Ludwigshafen, Germany
(sandra.smeltzer@queensu.ca, www.cunninghamlab.ca)

With advances in reversible deactivation radical polymerization (RDRP) techniques allowing for the synthesis of previously unimaginable materials, amphiphilic copolymers continue to attract interest due to the high amount of microstructural tailoring that can be done to meet applications in various fields. Block copolymers comprised of styrene and acrylic have been extensively investigated in regards to their self-assembly behaviour and performance as stabilizers in emulsion polymerization. Despite the vast potential of these materials, direct dispersion into water is typically not possible, making the formation of copolymer micelles complex and tedious. Our group has recently developed polystyrene-*b*-(poly(styrene-*r*-(acrylic acid)) block-random copolymers which can directly disperse in water at concentrations up to 300 g/L,[1] compared to less than 1 g/L with analogous block copolymers. In this talk, the self-assembly behaviour of block-random copolymers is explored as a function of molecular weight and composition. This work will enable the intelligent design of block-random copolymers for use as stabilizers in emulsion polymerization, where they have been shown to lead to a unique and seemingly robust nucleation mechanism, as well as other potential applications in fields such as catalysis and biomedicine.

Keywords: amphiphilic copolymers, self-assembly, structure-property relationships.

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SL-11

MANIPULATING THE INTRAPARTICLE FÖRSTER RESONANCE ENERGY TRANSFER OF ORGANIZED RADIOLUMINESCENT PARTICLES

H. Jones[a,b], Y. Bandera[a,b], S. Foulger[a,b]

[a]*Center for Optical Materials Science and Engineering Technologies (COMSET), Clemson University, 91 Technology Dr., Anderson, SC 29625 USA*

[b]*Department of Materials Science and Engineering, Clemson University, 91 Technology Dr., Anderson, SC 29625 USA*

(foulger@clemson.edu)

The effect of the local density of optical states (LDOS) on the Förster resonance energy transfer (FRET) between two emitters remains a highly debated topic with conflicting reports in the literature. In this work, three emitters that are FRET pairs with each other were copolymerized within a poly(styrene-co-propargyl acrylate) crystalline colloidal array (CCA) composed of electrostatically stabilized ca. 150 nm particles. By covalently incorporating the emitters, the photonic environment was manipulated using the CCA's rejection wavelength, while the individual emitters remained chemically and physically unchanged within the colloidal nanoparticles. The three emitters copolymerized in the CCA were modified anthracene (An), naphthalimide (Nap), and rhodamine B (RhB) derivatives, where An/Nap and Nap/RhB are FRET pairs. When excited by an x-ray source, a sequential energy transfer occurred such that the maximum emission of the CCA was at 607 nm. In this triple emitter system, nanophotonic control over the CCA's radioluminescence was exhibited by adjusting the rejection wavelength through the CCA's radioluminescence and quantifying the resultant suppression in emission at that wavelength. Moreover, nanophotonic manipulation of x-ray induced FRET between two pairs of emitters was observed, indicating a relationship between the LDOS and FRET. Specifically, the FRET efficiency between two emitters was increased or decreased by suppressing the donor or acceptor's emission with the CCA's rejection wavelength, respectively.

SL-12

WATER FLOW GENERATED BY THERMO-RESPONSIVE VOLUME CHANGE OF HYDROGELS POWERED BY DIURNAL TEMPERATURE VARIATION

J. Lee, J. Han, C. C. Lee, S. Lee, H. Kim, J. Kim, Y. Cho

Department of Chemical Engineering and Material Science, Chung-Ang University, Seoul 06974, Republic of Korea (jong@cau.ac.kr, https://nanostructurelab.wordpress.com/)

Water management that is both energy-efficient and environmentally friendly is a pressing issue that must be addressed, and nonpowered water pumps and filters could be critical foundations in future society. Further, nonpowered water management, such as water pumps and purifiers powered by diurnal temperature variation, can supply energy-saving and ecologically friendly solutions to all water consumption applications. A new system of thermo-responsive hydrogels is used to pump and filter water in this study, and the sole power source is diurnal temperature variation.[1] The composites were prepared by infiltration of silicone into a porous foam of dried hydrogels. The porous hydrogels were prepared by directional melt crystallization of water and subsequent removal of ice. This whole process prepared 3D co-continuous composites with relatively fast thermal response and hydrophobic nature. An anisotropic xylem-mimetic device with a composite phase that serves as a water channel valve draws up water at night and releases it during the day. The effectiveness of water pumping varies from 78 % to 92 %, and the weights of pumped water each cycle are 2–3 times that of the pumping materials. The use of water purifying hydrogels to remove dye or oil impurities improved the usability of our innovative system. This non-powered water pumping and purification material offers a new cost-effective and ecologically friendly method for water consumption in all regions.

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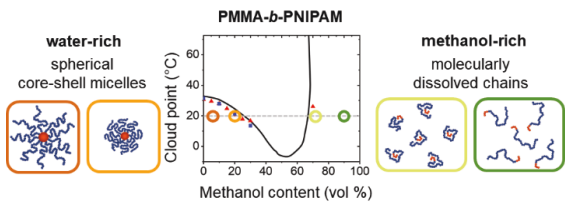
SL-13

CONONSOLVENCY IN SELF-ASSEMBLED, THERMORESPONSIVE MICELLES FROM PMMA-PNIPAM

C.-H. Ko[a], C. Henschel[b], P. Müller-Buschbaum[a], A. Laschewsky[b], C. M. Papadakis[a]

[a]*Physics Department, Technical University of Munich, James-Franck-Str. 1, 85748 Garching, Germany*
[b]*Institut für Chemie, Universität Potsdam, Karl-Liebknecht-Str. 24-25, 14476 Potsdam-Golm, Germany*
(papadakis@tum.de, www.softmatter.ph.tum.de)

Thermoresponsive amphiphilic diblock copolymers self-assemble into micelles in aqueous solution, and their morphology is adjustable by altering temperature. Here, we investigate the self-assembly behavior of the diblock copolymer PMMA-*b*-PNIPAM made of a short permanently hydrophobic poly(methyl methacrylate) block and a long thermoresponsive poly(*N*-isopropylacrylamide), that features lower critical solution temperature behavior.[1] Below the cloud point T_{CP}, spherical micelles are present in aqueous solution, having a PMMA core and a hydrated PNIPAM shell. Above T_{CP}, the micellar shell dehydrates, and the micelles contract. Adding methanol as a cosolvent causes the shell to collapse due to the so-called co-nonsolvency effect, and the incompatibility of the PMMA block with water to decrease. We find that the internal morphology of the micelles and the conformation of the dissolved chains depend strongly on the solvent composition, as a consequence of the superposed co-nonsolvency effect of PNIPAM and the overall enhanced solvation of PMMA when adding methanol.[2]



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SL-14

BIOFUNCTIONAL POLYMER BRUSH COATINGS ON THE NANOSCALE

I. Romanenko[a], A. Cernescu[b], R. Sivkova[a], J. Svoboda[a], Y.-M. Wang[a], W.-T. Hsu[a], V. Proks[a], A. de los Santos Pereira[a], O. Pop Georgievski[a]

[a]Institute of Macromolecular Chemistry, Czech Academy of Sciences, Heyrovského nám. 2, 162 06 Prague 6, Czech Republic
[b]neaSPEC, Attocube systems AG, Wittenstein Group, Eglfinger Weg 2, D-85540 Munich-Haar, Germany
(georgievski@imc.cas.cz, www.imc.cas.cz)

Biofunctional polymer layers composed of antifouling polymer brushes and containing extracellular matrix-derived peptide motifs offer promising new options for biomimetic surface engineering.[1] We utilize grafting-to and grafting-from synthesis methods for attaining the polymer brush conformation, and further functionalize the brushes with various biomimetic peptide sequences, such as RGD and TYRAY. The characterization of obtained systems goes beyond the state-of-the art findings based on far-field analytical techniques for proving the brush character of the synthesized polymer structures, their antifouling character and the biofunctionality induced by the presence of various peptide motifs. By utilizing mid-infrared nanoscopy methods we unravel the conformation and orientation of the individual polymer chains constituting the polymer brush films[2] and directly determine the distribution of bifunctional peptides with a nanoscale resolution. We foresee that measurements under controlled temperature, humidity, or in liquids will give further physicochemical insight into bioactivity of these polymer brushes architectures.[2,3]

Acknowledgement: *Financial support from Czech Grant Foundation (grant No. 20-07313S) is gratefully acknowledged.*

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SL-15

SUPERFERRIMAGNETIC CURCUMIN DERIVATIVES NANODISPERSION FOR MAGNETIC FLUID HYPERTHERMIA

M. Coupeau, M. Chauvet, L. Lartigue

Université de Nantes CNRS Faculté des Sciences et Techniques, Chimie et Interdisciplinarité : Synthèse, Analyse, Modélisation (CEISAM), UMR CNRS n° 6230, 2, rue de la Houssinière BP 92208 44322 NANTES Cedex 3, France
(lenaic.lartigue@univ-nantes.fr)

Magnetic fluid hyperthermia consists of the application of an external high-frequency alternating magnetic field on magnetic nanoparticles (MNPs) suspension, commonly iron oxide nanoparticles, to generate local heating. Nevertheless, to obtain an efficient heating, a high concentration of MNPs is necessary, which can lead to toxicity issue. To drastically increase heating properties, ordering several MNPs in nanoassembly is a promising route. Among these assemblies, superferrimagnetic nanodispersion are the most promising. In order to preserve this magnetic order, the control of nanoassembly size is crucial. In this approach, we propose to use a curcumin matrix to encapsulate MNPs.

Curcumin presents anti-inflammatory and anti-cancer activities.[1] However, curcumin is not stable under basic condition or light irradiation.[2]

By using, a flash nanoprecipitation method, iron oxide MNPs are efficiently encapsulated into curcumin matrix to lead a monodisperse hybrid nanodispersion with variable size. Heating efficacity of nanoassemblies will be tested to highlight correlation between nanodispersion size and amount of MNPs in the organic matrix.

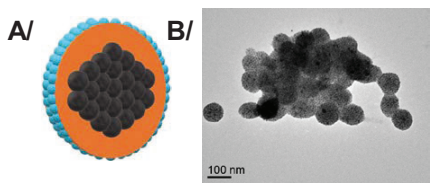

Figure 1. A/ Schematic representation of nanoassemblies. B/ TEM image of nanoassemblies.

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SL-16

AMPHIPHILIC BLOCK COPOLYMERS: FROM SYNTHESIS TOWARDS BIOMIMETIC POLYMER MEMBRANES

I. A. Dinu[a,b], C. G. Palivan[a,b]

[a]Department of Chemistry, University of Basel, BPR1096, Mattenstrasse 24a, 4058 Basel, Switzerland
[b]NCCR-Molecular Systems Engineering, BPR1095, Mattenstrasse 24a, 4058 Basel, Switzerland
(adrian.dinu@unibas.ch, cornelia.palivan@unibas.ch, https://palivan.chemie.unibas.ch)

Biomimetic membranes are on demand in various domains ranging from medicine up to water purification technologies. Amphiphilic block copolymers represent an appealing solution for development of biomimetic membranes as they provide higher mechanic stability and a better control of properties by the choice of their chemical nature.[1-3] We present here various libraries of amphiphilic block copolymers, which successfully form symmetric or asymmetric membranes that structurally resemble the cell membranes. Such soft membranes allow insertion/attachment of a plethora of active compounds, including catalysts and biomolecules that are inducing them a specific functionality.[2,3] These artificial membranes supported the insertion of transmembrane proteins or biopores even for high hydrophobic mismatch between the protein size and the membrane thickness.[4] Protein-synthetic membrane systems represent ideal candidates for various applications, including mimics of natural organelles and cells, functional surfaces or molecular factories.[3,5]

Keywords: amphiphilic block copolymers, self-assembly, biomimetic membranes.

Acknowledgement: *National Centre of Competence in Research – Molecular Systems Engineering (NCCR-MSE) and University of Basel are acknowledged for the research funding.*

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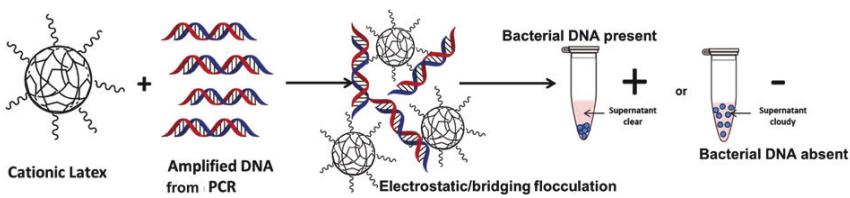
SL-17

USING BRIDGING FLOCCULATION FOR THE DEVELOPMENT OF A POLYMER-BASED POINT-OF-CARE DIAGNOSTIC FOR TARGETED DETECTION OF DNA

E. Trinh, L. A. Fielding

Department of Materials, Henry Royce Institute, University of Manchester, Manchester M13 9PL, United Kingdom
(elisabeth.trinh@manchester.ac.uk)

The current gold standard diagnostic for bacterial infections is the use of culture, which can be time consuming and can take up to five days for results to be reported. There is therefore an unmet clinical need for a rapid and cost-effective alternative. This paper demonstrates a method of detecting the presence of amplified DNA from bacterial samples using polymer latexes and widely available equipment, providing an accessible alternative to more expensive DNA detection techniques. If DNA is present in a sample, it's successful amplification results in flocculation of the polymer latex followed by rapid sedimentation, thus giving a clear visual result. The sensitivity and speed of the test has been investigated using a combination of disc centrifuge photosedimentometry, UV-Visible spectrophotometry and aqueous electrophoresis. To-date, label-free detection of DNA has been achieved at amplified DNA concentrations as low as 0.57 ng/µl within 2 hours from the start of amplification to detection.



Keywords: flocculation, diagnostic, latex.

Acknowledgement: *Dr Gavin Humphreys, Department of Pharmacy and Optometry, Faculty of Biology, Medicine and Health, University of Manchester.*

SL-18

LUMINESCENCE NANOTHERMOMETRY TECHNOLOGY FOR INTRACELLULAR TEMPERATURE IMAGING

R. Piñol[a], Y. Gu[a], C. D. S. Brites[b], J. Zeler[b], L. D. Carlos[b], A. Millán[a]

[a]*Instituto de Nanociencia y Materiales de Aragón, CSIC – Universidad de Zaragoza, Facultad de Ciencias, 50009 Zaragoza, Spain*
[b]*Departamento de Física and CICECO, Aveiro Institute of Materials, Universidade de Aveiro, 3810-193 Aveiro, Portugal*
(pinol@unizar.es)

Accurate, precise and noninvasive monitoring of subcellular temperature changes in individual cells might help to clarify cellular processes and led to the development of new diagnostic and therapeutic technologies. For example, Magnetic Hyperthermia using magnetic nanoheaters (MNHs) can be a powerful non-invasive technique for cancer treatment. The capacity and efficiency of such local heating systems should require of an adequate local temperature control of the MNHs. Therefore, single nanoparticles integrating both functions, magnetic heating and temperature sensing should be the best option.[1] Most of the thermometric systems proposed for intracellular thermometry are noncontact luminescent nanothermometer (LNT). Here, we present a ratiometric luminescent nanothermometer based on Lanthanide complexes (Ln = Sm^{3+}/Eu^{3+}) covalently bonded on amphiphilic block copolymers. The adequate selection of the lanthanide complexes combined with the protection provided by the polymer coating have enabled to obtain new MNH-LNT and thermometric micelles,[2] two robust systems that preserve their thermometric properties within the intracellular medium. Making use of these luminescent probes, we have been able to record two-dimensional (2D) cellular thermal images and measuring local temperature gradients during the application of intracellular magnetic hyperthermia.

Acknowledgement: *This work was supported by the Spanish Ministry of Science Innovation and Universities [Grant No: PGC2018_095795_B_I00] and Diputación General de Aragón [E11/17R]. The support of the European Union's Horizon 2020 FET Open program under grant agreements No. 801305 (NanoTBTech) and 829162 (Hotzymes) is also acknowledged.*

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SL-19

OPTICAL BIOSENSORS VIA HOLOGRAPHIC LITHOGRAPHY

Y. Hu, A. K. Yetisen

Department of Chemical Engineering, South Kensington Campus, Imperial College London, London SW7 2AZ, United Kingdom (yubing.hu@imperial.ac.uk)

Optical techniques have intensively contributed to modern healthcare technologies. Lasers and optical devices are frequently used in clinical practice for diagnosis and treatment. Recent advances in photonic structures have enabled numerous technological applications, particularly the integration with biochemical sensors. Herein, a facile and efficient holographic photolithography technique has been developed to fabricate a 1D photonic crystal sensor that provides quantitative and continuous response to chemical analytes in aqueous solutions (Figure 1).[1] Holographic laser lithography was achieved *via* a single Nd:YAG laser pulse (λ=355 ns, 5 ns) to initiate the localized photopolymerisation of nanoscale fringes in a functional hydrogel matrix. Computational modelling was conducted to simulate the image recording and the Bragg diffraction performances. Thickness, monomer ratio and crosslinking density of the holographic sensors were controlled to optimise sensor performance. The holographic sensors displayed reversible and rapid colorimetric response to pH changes over the physiological range. The developed holographic pH sensors as continuous analytical devices have been tested in serum and an *ex vivo* skin model for application in point-of-care diagnostics.

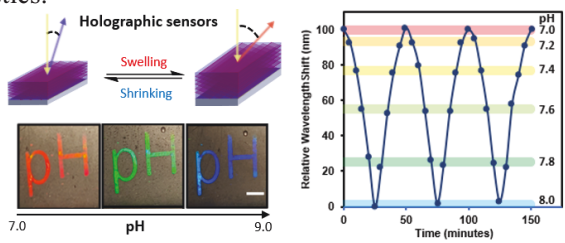

Figure 1. Holographic sensors fabricated through holographic laser interference lithography in responsive hydrogels for continuous pH monitoring.

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SL-20

NANOPARTICLE-IMPRINTED HYDROGEL FOR SELECTIVE RECOGNITION OF NANOPARTICLES IN WATER SAMPLES

Y. Y. Tay, X. H. Lin, S. F. Y. Li

Department of Chemistry, National University of Singapore, 3 Science Drive 3, Singapore, 117543, Republic of Singapore (chmlifys@nus.edu.sg, www.samlilab.com)

Nanoparticles (NPs) represent emerging pollutants that still pose analytical challenges for their detection in environmentally relevant samples, due to their extremely low concentrations, high colloidal background and the need to perform speciation analysis. They are also one of the interfering matrices during the analysis of metal ions and contaminants in water samples. Currently, conventional analytical techniques such as Transmission Electron Microscopy (TEM) and Inductively Coupled Plasma Mass Spectrometry (ICP-MS) are used for the detection of NPs, but such techniques require bulky instrumentation and are difficult to be automated for online analysis. In this study, we aim to develop a nanoparticle-imprinted hydrogel (NPIH) to detect and capture NPs in water samples. The principle of the NPIH originates from the well-known concept of molecularly imprinted polymers (MIPs). Cadmium sulfide/ selenide/zinc sulfide core/shell quantum dots (QDs) were used as the template NP, creating specific pore cavities in the NPIH that are able to selectively bind to certain analytes. Quantification of NPs detected in water samples was then made possible by transducing this selective detection process into an analytical signal, using the quartz crystal microbalance (QCM). The NPIH was shown to demonstrate good repeatability, reproducibility and stability in terms of its performance. Additionally, the selectivity of the NPIH was explored and determined to be based on the size and surface characteristics of the analytes present. Lastly, an important point to note is that the NPIH was also able to detect and uptake ions, acting as a significant source of interference.

SL-21

STRUCTURES AND PROPERTIES OF HYDROGELS CONTROLLED BY COORDINATION BOND GEOMETRIES

J. Lee, J. Ryu, D. Sohn

Department of Chemistry and Research Institute for Convergence of Basic Science, Hanyang University, Seoul 04763, Korea

Metal complexation–based gelation imparts load-bearing hydrogels with striking properties like reversibility, self-healing, and mechanical tunability. Using a bio-inspired metal-catechol complex, these properties have been introduced to a variety of polymer hydrogels. We developed hyaluronic acid (HA) hydrogels by regulating the gelation kinetics of $Fe^{3+}$and a catechol cross-linker, including Fe^{3+}-induced covalent bonding and coordination bonding. Dual roles of Fe^{3+} in catechol-modified HA (HA-CA), Fe^{3+}-catechol coordination, and catechol oxidation followed by a coupling reaction, were selectively applied for different gelations. Tetra-poly(ethylene glycol) with catechol end groups (4-PCA) was also crosslinked through coordination bonds between catechol moieties and Fe(III) ions, which produce bis-complex and tris-complex depending on pH levels. The structure and property of 4-PCA gels were examined upon the bonding types controlled by pH levels and molar ratios between catechol groups and Fe(III) ions. The coordination bond types were probed by UV absorption peaks and Raman spectra. The correlation lengths (ξ) were determined in the semi-dilute solution regime and the PCA gel networks using light scattering, small-angle X-ray scattering, and neutron scattering measurements. For the gels with bis-complex units, ξ values correspond to the size of a single polymer chain. Otherwise, they increased in the gels consisting of tris-complex units, indicating that the matrices have partial crosslinks. The results show structure and property of gels can be controlled by geometries of crosslinking units as a strategy to develop novel polymer gels.

SL-22

HYDROGEL FOAMS BASED ON BIOTINYLATED GELATIN METHACRYLOYL FOR IMPROVED ENZYME SUBSTRATE CONVERSION

F. Dehli[a], C. Stubenrauch[a], A. Southan[b]

[a]*Institute of Physical Chemistry, University of Stuttgart, Pfaffenwaldring 55, 70569 Stuttgart, Germany*
[b]*Institute of Interfacial Process Engineering and Plasma Technology, University of Stuttgart, Nobelstraße 12, 70569 Stuttgart, Germany*

Hydrogels are widely used as functional materials in the field of enzyme immobilization since they provide a suitable aqueous environment.[1] To generate hydrogels for enzyme immobilization, functionalized polymers are needed that enable the bioconjugation of enzymes. In this work, biotinylated gelatin methacryloyl (GM10EB) was synthesized in a three-step procedure starting from gelatin.[2] The dual functionalization of gelatin allows for the formation of hydrogels via radical cross-linking of the methacryloyl groups and for the immobilization of enzymes via the biotin-streptavidin interaction. The substrate conversion of immobilized enzymes was assessed for hydrogels with two different morphologies, namely foamed hydrogels, which were prepared by liquid foam templating,[3] and non-foamed hydrogels. For foamed hydrogels, a twelve times increased substrate conversion rate was found compared to non-foamed hydrogels.

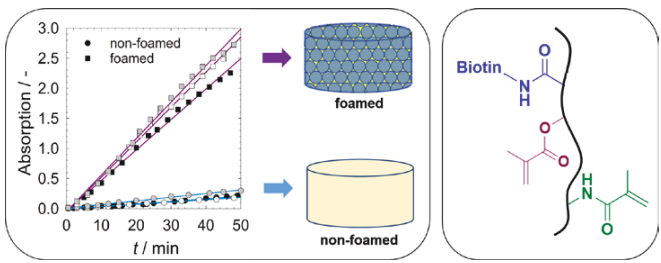

Figure 1. Substrate conversion in foamed and non-foamed hydrogels (left) based on GM10EB (right).

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SL-23

MODIFICATION OF POLYMERS WITH POWERFUL ANTIMICROBIAL COATINGS

I. Rezić[a], L. Pintarić[a], M. Somogyi Škoc[a], S. Jakovljević[b], V. Ljoljić Bilić[c], I. Kosalec[c]

[a]Faculty of Textile Technology, University of Zagreb, Croatia
[b]Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb, Croatia
[c]Faculty of Pharmacy and Biochemistry, University of Zagreb, Croatia
(iva.rezic@ttf.hr, www.ttf.hr/index.php?str=53&osoba=75&lang=en)

According to some predictions, by the year 2050, from the infections caused by antibiotic-resistant bacteria more people could die than from AIDS, tuberculosis and viral hepatitis together. Only in Europe 25,000 deaths per year and costs over € 1.5 billion are caused by resistant microorganisms. In this presentation, therefore, the production of new biodegradable materials will be reported with focus an antimicrobial active coating for medical textiles active against *Staphylococcus Aureus MRSA* and *MSSA* strains resistant to antibiotics.

Metal nanoparticles are very efficient antimicrobial agents.[1] Therefore those were chemically bonded to the polymer surface by sol-gel process in order to obtain antibacterial functionalized material. Particularly Ag and ZnO nanoparticles were efficiently applied at low temperature and atmospheric pressure, and homogenous coating was obtained. Materials were investigated by SEM-EDX, NTA, FTIR and TLC methodologies. Antibacterial testing proved that this material is an effective antibacterial surface active not only against model microorganisms, but also against clinical strains of microorganisms resistant to antibiotics, such are MRSA and MSSA.[2]

Acknowledgement: *This work was financially fully supported by the Croatian Science Foundation, project IP-2019-04-1381 under title „Antibacterial coating for biodegradable medicine materials ABBAMEDICA“. Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of Croatian Science Foundation.*

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SL-24

MULTIFUNCTIONAL LAYER-BY-LAYER COATINGS FOR CARDIOVASCULAR METALLIC STENTS

G. Azizi Saadatlou[a], P. Tatar Güner[b]

[a]*Koç University, Mat. Sci. & Eng. Graduate Program, Istanbul, Turkey*
[b]*Koç University, Chemistry Department, Istanbul, Turkey*
(ptatar@ku.edu.tr)

Multilayer coatings were deposited on coronary stent alloy surfaces (316L stainless steel and nitinol) via layer-by-layer deposition technique. The substrates were coated with poly(2-ethyl-2-oxazoline)-co-linear polyethyleneimine (PEOX-co-LPEI) stabilized silver nanoparticles and heparin to enhance metal corrosion resistance in physiological conditions, improve the cell and blood compatibility of substrates, and add antibacterial activity to the surfaces. According to literature polycationic PEI containing coatings have great potential to enhance corrosion behavior of metals.[1] However, polycationic macromolecules like PEI are cytotoxic due to their effect on membrane integrity and metabolic activity.[2] In this study, we have suggested a cell compatible coating that enhances corrosion resistance and demonstrates antibacterial activity and hemocompatibility. Partial acidic hydrolysis of PEOX was used to control PEI segments amount and the subsequent charge density on the backbone of copolymer thus, decreasing PEI cytotoxicity while keeping its anticorrosive property. MTT assay was performed with HUVEC cells where relative viability of the coated samples was more than 80 %. Tafel plots obtained via potentiodynamic polarization measurements in PBS solution at 37 °C and confirmed a significant improvement in the corrosion resistance. The desired blood compatibility expected from heparin molecules was confirmed with coagulation assay. Silver nanoparticles demonstrated significant antibacterial activity against model gram-positive and gram-negative bacteria which was confirmed with modified JIS Z 2801 standard.

Acknowledgement: *The authors would like to acknowledge Turkish Scientific and Technological Research Council (TUBITAK-118Z199) for financial support.*

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SL-25

INTERACTION OF NON CANONICAL TELOMERIC DNA FRAGMENTS WITH CARBON NANOTUBES IN AQUEOUS SOLUTIONS. INSIGHTS FROM MOLECULAR SIMULATIONS

T. Panczyk, P. Wolski, P. Wojton

Jerzy Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, ul. Niezapominajek 8, 30239 Krakow, Poland (tomasz.panczyk@ikifp.edu.pl)

Calculations were performed on the interaction of the i-motif (iM) DNA sequence with functionalized carbon nanotubes.[1] The systems were designed in order to determine whether the structural changes of the iM sequence as a function of the environment pH could be used for the controlled release of doxorubicin. A model was constructed to investigate the intercalation ability of doxorubicin by iM molecules non-covalently attached to the surface of a carbon nanotube. It turned out that such mixed systems do indeed form stable ternary structures. However, removal of doxorubicin from the system significantly diminished the efficiency of iM binding to CNT. Therefore, the method and efficiency of doxorubicin binding in the three-component system and then in the two-component system were investigated in more detail - which allowed for a deeper study of the mechanism of doxorubicin binding to iM. The determined values of the binding energy, the number of formed clusters and the surface available for the solvent in the three-component systems suggested that DOX binds more strongly at neutral pH than in acidic pH and it will probably detach under conditions when the iM obtains the form typical for acidic pH.
The conducted research leads to the conclusion that DOX can be immobilized in the iM system forming a cluster at neutral pH and released in an acidic environment. It is an additional possible mechanism not described in the literature so far. Previous literature data postulated that DOX must be intercalated within the duplex at neutral pH and released when the duplex breaks at acidic pH and the spatial form of iM is formed.

Acknowledgement: *This work was supported by Polish National Science Centre grant 2017/27/B/ST4/00108.*

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SL-26

NOVEL COMPOSITE NANOFIBERS BY GREEN ELECTROSPINNING

E. Gonzalez[a], A. Barquero[a], E. Stefanovska[b], M. Paulis[a], J. R. Leiza[a]

[a]POLYMAT and Kimika Aplikatua Saila, Kimika Fakultatea, University of the Basque Country UPV/EHU, Joxe Mari Korta Zentroa, Tolosa Hiribidea 72, Donostia-San Sebastián 20018, Spain
[b]Faculty of Technology and Metallurgy, Ss Cyril and Methodius University, Ruger Boshkovikj 16, Skopje 1000, Republic of North Macedonia
(edurne.gonzazlezg@ehu.eus)

Green Electrospinning is a relatively new promising technology that consists in the electrospinning of an aqueous polymer dispersion (latex) with the help of a template polymer. This method is a green, clean and safe technology that allows to spun hydrophobic polymers using water as electrospinning medium.[1-3] Additionally, by the use of polymer particles of different morphologies, compositions and functionalities nanofibers with unique properties and morphologies can be obtained.

In this work, a systematic study that investigates the influence of different variables on fibre morphology has been performed. The analysed variables are the latex/template ratio, the particle size and particle size distribution, the surface functionalization, the surfactant type and the total solids content[3]. Additionally, novel hybrid organic/inorganic nanofibers have been produced for their potential use in sensor or purification applications.

Acknowledgement: *The financial support from the Ministerio de Ciencia e Innovación (PID2020-117628RJ-I00) is gratefully acknowledged.*

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SL-27

VISUALIZING DIFFUSIOPHORESIS AND PARTICLE-SIZE-SEGREGATION IN A DRYING COLLOIDAL DROPLET CONTAINING MIXED-SIZED PARTICLES

Z. Jiang[a], J.-B. Salmon[b], H. D. Ou-Yang[a,*]

[a]*Physics Department, Lehigh University, USA*
[b]*CNRS, Solvay, LOF, UMR 5258, University of Bordeaux, F-33600, Pessac, France*
(hdo0@lehigh.edu)

Particle segregation during drying of mixed-sized colloidal dispersion was observed and attributed to diffusiophoresis by which the large particles migrate in a concentration gradient of the small ones. However, direct observations of particle migration or segregation has not been experimentally observed partly because in situ visualization of these phenomena is difficulty. In addition, effects such as convection or sedimentation due to particle-solvent mass-density mismatch, that could also yield particle segregation, were difficult to remove. To eliminate density mismatch-induced sedimentation and free convection, we performed drying experiments of 2D confined droplets of polystyrene colloidal particle dispersed in a H2O/D2O mixture so that the mass-densities of the particles and the solvent were perfectly matched. Using time-lapse fluorescence confocal microscopy, we measured the concentration distributions of 100 nm diameter fluorescent particles (initially at 6% volume fraction) and simultaneously tracking the motion of the differently color-labeled 1.3-micron diameter particles (initially at 10^{-4} volume fraction). The drift speed of large particles was found to depend on both the concentration gradient of the small particles and the salt concentration of the dispersion. At concentration range up to 20% of the small particles, our experiments show diffusiophoresis agree quantitatively with the classical models. Significant deviations with the theoretical prediction were observed at higher concentration of small particles, suggesting possibly that diffusiophoresis is hindered by crowding of the large particles. Spatiotemporal segregation of large particles toward the center of the 2D drying cell was clearly seen to grow as drying times were progressing.

SL-28

POLY(TERT-BUTYL METHACRYLATE) FILM INTERACTIONS WITH PEPTIDES, PROTEINS, AND BACTERIA: EFFECT OF POLYMER STEREOREGULARITY

N. Janiszewska[a], J. Raczkowska[a], M. Brzychczy-Włoch[b], T. Gosiewski[b], K. Gajos[a], K. Awsiuk[a]

[a]*M. Smoluchowski Institute of Physics, Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University, Łojasiewicza 11, 30-348 Kraków, Poland*

[b]*Chair of Microbiology, Department of Molecular Medical Microbiology Faculty of Medicine, Jagiellonian University Medical College, 31-121 Krakow, Czysta 18 Street, Poland (kamil.awsiuk@uj.edu.pl, biophysics.fais.uj.edu.pl/)*

The impact of polymer stereoregularity on its interactions with peptides, proteins and bacteria strains was studied for three stereoregular forms of poly(tert-butyl methacrylate) (PtBMA): isotactic (iso), atactic (at) and syndiotactic (syn) PtBMA. Principal component analysis of the time-of-flight secondary ion mass spectrometry data recorded for thin polymer films indicated a different orientation for polymer side chains, which in the case of iso-PtBMA are exposed away from the surface whereas for at-PtBMA and syn-PtBMA these are located deeper within the film. This arrangement of side chains modified the interactions of iso-PtBMA with biomolecules when compared to at-PtBMA and syn-PtBMA. Exposition of polar ester groups of iso-PtBMA promote electrostatic interaction and hydrogen bonding with positively charged peptides. However, for more complex molecules such as proteins equally other kinds of interactions have to be taken into account. Electrostatic interaction is responsible for the orientation of IgG molecules, while in turn hydrophobic interaction impacts on the conformation of BSA. Moreover, gram-positive *S. aureus* bacteria are also sensitive to the exposition of chemical groups at the surface of a polymer film and, as a result, more bacteria cells were able to attach themselves onto iso-PtBMA films when compared to two other stereoregularities. In turn, no differences were observed for gram-negative E. coli.

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SL-29

WATERBORNE DEGRADABLE POLYESTER NANOPARTICLES

F. Wenzel, M. Aguirre, J. R. Leiza

POLYMAT and Kimika Aplikatua Saila, Kimika Fakultatea, University of the Basque Country UPV-EHU, Joxe Mari Korta Zentroa, Tolosa Hiribidea 72, 20018 Donostia-San Sebastian, Spain (miren.aguirre@ehu.eus)

During the recycling process of glass bottles one of the main issues that industry has to face is the removal of the labels or stickers from the glass substrate. The processes that the industry is using nowadays to remove the labels and adhesives from glass are energy demanding, since high temperatures and large times are needed under either acid or basic conditions. To overcome this problem, a novel approach based on the synthesis of waterborne degradable pressure sensitive adhesives (PSAs) that enable easy removability of the adhesive tape will be presented. Degradable crosslinkers have been incorporated into an adhesive formulation by a two step seeded semibatch emulsion polymerization process.

Different symmetric and asymmetric oligoester crosslinkers were prepared by ring opening polymerization (ROP) of ε-caprolactone and lactide and they were used to replace the conventional crosslinker AMA in a waterborne PSA formulation. The oligoester crosslinkers were incorporated successfully into the PSA formulations. The molar mass distributions as well as the gel content revealed that the microstructure obtained was appropriate to use as PSA. The adhesive properties (peel resistance, tack, shear resistance and SAFT values) of the oligoester containing latex films were in the range of commercial PSAs and could be further tune by the oligoester chain length. Furthermore, the degradation of the PSA films was shown by probe tack measurements before and after their immersion in basic medium at room temperature. It was demonstrated that the adhesives showed a substantial decrease in their work of adhesion in short times as 30 min. Moreover, it has been shown that degradation is faster; the longer is the oligoester chain length.

SL-30

ENZYME METABOLIZABLE PEG-B-POLY(VINYL BUTYRATE) NANOMEDICINE SENSITIZES CANCER TO THE RADIOTHERAPY

B. Shashni[a], Y. Nagasaki[a,b,c]

[a]*Department of Material Sciences, Graduate School of Pure and Applied Sciences*

[b]*Master's School of Medical Sciences, Graduate School of Comprehensive Human Sciences*

[c]*Center for Research in Isotopes and Environmental Dynamics (CRiED), University of Tsukuba, Tennoudai 1-1-1, Tsukuba, Ibaraki 305-8573, Japan (shashni@ims.tsukuba.ac.jp)*

Butyric acid is a short-chain fatty acid (SCFA) metabolite produced by the gut microbiota by the fermentation of polysaccharides. It is known to alleviate cancer, non-alcoholic fatty liver, obesity, and diabetes pathogenesis by epigenetic regulations. Recently, an elegant study confirmed that butyric acid can sensitize human colorectal organoids for radiotherapy.[1] However, to the best of our knowledge, there are no reports of its in vivo efficacy in the tumor models yet, probably attributed to the poor pharmacokinetic profile of butyric acid. Because butyric acid is low molecular weight (LMW) compound, it is reported to rapidly clear from the systemic circulation leading to a low therapeutic effect. In addition, due to the non-specific distribution of LMW butyric acid severe adverse effects are also observed. To overcome these limitations, we synthesized a novel delivering agent PEG-b-poly(vinyl butyrate), which self-assembles to form nano-sized micelle ($Nano^{BA}$) in physiological conditions.[2] Conjugated butyric acids can release from the polymer backbone by enzyme-based hydrolysis. This design will greatly control the in vivo bioavailability of butyric acids due to which improvement in the therapeutic efficacy is anticipated. In this study, we will discuss how our carrier polymer design improved the pharmacokinetic properties of butyric acid which consequently contributed to a higher sensitizing effect on B16F10 tumors for radiotherapy as compared to LMW butyric acid.

Keywords: Short-chain fatty acids, butyric acid, radiotherapy, block co-polymer, self-assembling, nano-carrier, controlled release.

Acknowledgement: *Grant-in-Aid for Young Scientists (B) (20K20194) and Grant-in-Aid for Specially Promoted Research (19H05458) of the Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan.*

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SL-31

LATEXES STABILIZED BY AMPHIPHILIC BLOCK-RANDOM COPOLYMERS

A. Werner[a], C. Sanders[a], S. Smeltzer[a], S. George[b], A. Gernandt[c], B. Reck[c], M. F. Cunningham[a]

[a]*Department of Chemical Engineering, Queen's University, Kingston, Ontario, Canada*
[b]*BASF Corporation, Charlotte, North Carolina, USA*
[c]*BASF SE, Ludwigshafen, Germany*
(aw173@queensu.ca)

Block-random copolymers (BRCs) are a new class of copolymers combining the concepts of block and random copolymers. By using a hydrophobic block conjugated with an amphiphilic tail such as polystyrene-b-[polystyrene-r-poly(acrylic acid)], with a typical overall content of 80 % of styrene, emulsion polymerization stabilizers were synthesized. The amphiphilic tail assures a high dispersion rate in alkaline water at concentrations up to 300 gL^{-1}.[1] As emulsion polymerization stabilizers, the unique chemical structure allows electrostatic stabilization of latexes while keeping a thin diffuse layer, limiting the latex viscosity increase observed with classic block copolymer stabilizers. This presentation will discuss the versatility and limitations of BRCs. This promising technology of polymer allowed the polymerization of PS latexes up to 60 % solids content with a relatively low viscosity. The extension of these BRCs to different polymers in each block, and other latexes (acrylates) will be discussed.

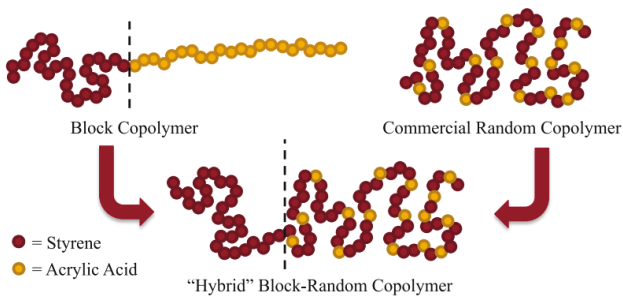

Figure 1. Block Random Copolymer concept.

Keywords: emulsion polymerization, block-random copolymer.

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SL-32

MECHANISTIC STUDIES OF LATEX FILM FORMATION OF LOW VOC WATERBORNE COATINGS

Y. Liu[a], K. Tran[a], M. Zhang[a], F. Lucas[b], M. Soleimani[c], M. A. Winnik[a]

[a]Department of Chemistry, University of Toronto, Toronto, Ontario M5S 3H6, Canada
[b]BASF, Advanced Materials and Systems Research, 67056 Ludwigshafen am Rhein, Germany
[c]BASF, Advanced Materials and Systems Research, Wyandotte, Michigan 48192, USA

Concern for the environment has been driving significant changes in the coatings industry, for example to reduce the amount of volatile organic compounds (VOCs) released into the atmosphere. Water-based coatings consist of dispersions of polymer particles in water that coalesce to form films upon drying. For many years the Winnik group has been interested in the final step in latex film formation: polymer diffusion across the interparticle boundaries. Fluorescence response energy transfer (FRET) has been a useful technique for us in the study of latex film formation.

In this talk, I will review our work on two different systems. The first involved nanoparticles (NPs) based upon emulsification of a low molecular weight acid-rich styrene-acrylic copolymer, in which the ―COOH groups were partially neutralized by ammonia. The molecular weight of the polymer was built up, and partial gel content was introduced via a reaction in the dispersed state with a bis-epoxide. Films cast from the dispersion were shown to undergo different rates of polymer interdiffusion at the air interface and at the substrate interface.

In the second system, we explored mechanistic details at a molecular level of a water-borne 2K polyurethane (WPU) formulation based on an acrylic latex polyol and a hydrophilically modified polyisocyanate (hmPIC).[2] We were able to study the interaction between the PIC and polyol in the dispersed state. In films cast from these dispersions, we found that the hmPIC acts as a reactive plasticizer to promote diffusion on a much faster scale than the cross-linking reactions.

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SL-33

REPROCESSABLE AND TUNABLE NITRILE ELASTOMERS ENABLED BY COVALENT ADAPTABLE NETWORKS USING A REACTIVE EPOXY POLYMERIC CROSSLINKER PREPARED VIA EMULSION POLYMERIZATION

N. A. Samad[a, b], R. A. Majid[b], C. H. Chan[a], Y. F. Goh[a], Z. L. Wei[a]

[a]*Synthomer Sdn Bhd, No. 73, Jalan i-Park 1/8, Kawasan Perindustrian i-Park, Bandar Indahpura, 81000 Kulaijaya, Johor Darul Takzim, Malaysia*
[b]*School of Chemical and Energy Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, UTM Johor Bahru, 81310, Johor, Malaysia*
(chihoong.chan@synthomer.com, www.synthomer.com)

Sulphur-vulcanization curing is a commonly used curing process for nitrile gloves, wherein a nitrile latex film is dried and covalently crosslinked to achieve optimal properties. Such gloves contain accelerator contact allergens, which may give Type IV allergy to end users.[1] Furthermore, they are neither reprocessable nor biodegradable, which pose an environmental concern. Herein, we report a novel curing strategy under SyNovus™ technological platform for nitrile gloves using a novel nitrile latex crosslinker, reactive epoxy polymeric crosslinker (REC) prepared via emulsion polymerization. Our results demonstrated that the mechanical properties of the nitrile films can be regulated by changing the zinc oxide content (shown in Figure 1) and REC content. The nitrile films cured with REC exhibited significantly faster stress relaxation and found to have better tensile properties after reprocessing by twin roll mill at 150 °C for 15 min, compared to that of conventional, sulphur-vulcanized gloves. Such property may lead to good reprocessability and may provide a new approach to recycling of single use nitrile glove.

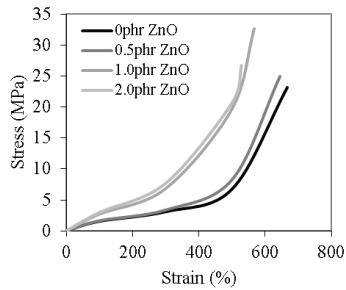

Figure 1. Stress-Strain Curve of nitrile latex film crosslinked with REC of varying ZnO content.

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SL-34

INFLUENCE OF SOLVENT EXPOSURE ON CLEAR, SOFT POLYURETHANE AND POLYACRYLATE@POLYURETHANE COATINGS

G. Ersek, R. Prakash, R. Jansen, G. Portale

Physical chemistry of polymeric and nanostructured materials group, Zernike Institute for Advanced Materials, University of Groningen, The Netherlands
(g.ersek@rug.nl)

For everyday application of commercial resins, it is essential to understand these formulations' barrier and mechanical properties. Such industrially relevant systems are polyacrylate/polyurethane (PAc@PU) coatings.[1] In this contribution we analyze their structural resistance at the nanoscale to the exposure against water, wine and ethanol using small angle X-ray scattering (SAXS). Our results show that the water uptake of these coatings are low but measurable (< 5 w%). We've found that the swelling behavior is dominated by the PU matrix and water does not cause neither substantial nor permanent changes in the bulk structure of the materials. Conversely, when the films are exposed to ethanol containing solvents they undergo irreversible structural changes and the solvent uptake is remarkably higher than in the case of water.
Overall, our results highlight the beneficial effect of introducing the PAc component against the exposure to solvents. The higher the PAc amount, the better the solvent resistance. What is more, we compare the mechanical properties of the coatings before and after the solvent exposure. We can show that excellent barrier properties and tunable mechanical properties can be offered by the hybrid systems not by preventing the solvents to enter the coating, but rather by limiting the solvent penetration and allowing reversible swelling deswelling of the nanostructure.

Acknowledgement: *We would like to thank DSM Coating Resins B.V for their support for providing the latex samples. Moreover, we acknowledge the support of Jurgen Scheerder (Covestro) and Ilse van Hoeven van der Casteren (Covestro). This research received funding from the Dutch Research Council (NWO) in the framework of the ENW PPP Fund for the top sectors and from the Ministry of Economic Affairs in the framework of the 'PPS-Toeslagregeling'.*

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SL-35

SYNTHESIS OF MULTI-CARBON DOTS CROSSLINKED POLYETHYLENEIMINE PARTICLES FOR BIOLOGICAL APPLICATION

J. Liao[a,b], Y. Yao[a], C. H. Lee[a], D. Niu[c], Y. Wu[b], P. Li[a*]

[a]*Department of Applied Biology and Chemical Technology, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong*
[b]*State Key Laboratory of Oral Diseases, National Clinical Research Center for Oral Diseases, West China Hospital of Stomatology, Sichuan University, Chengdu, Sichuan, P. R. China.*
[c]*School of Materials Science and Engineering, East China University of Science and Technology, Shanghai, P. R. China, China*
(pei.li@polyu.edu.hk)

A novel synthetic strategy to prepare ultrabright multi-carbon dots crosslinked polyethyleneimine (PEI) particles, namely CDs@PEI, through self-assembly of hydrophobically modified PEI and *in situ* generations of carbon dots within monomer-swollen micelles will be discussed.[1] The resulting particles consist of numerous carbon dots, which are individually and homogeneously embedded within the PEI network. The CDs@PEI particles possess a synergistic effect of photoluminescent carbon dot and crosslink-enhanced emission of PEI, giving the particles with superior optical properties such as high fluorescence quantum yield to up to 66% in the aqueous system, excitation-dependent emission phenomenon, stable fluorescence in a wide pH range, and resistance to photobleaching. The potential biological application of the CDs@PEI particles as intrinsic fluorescence nanocarriers was evaluated including their cytotoxicity, biodistribution, pharmacokinetic properties, and clearance from the animal body.[2] The results demonstrate that the intrinsic photoluminescent PEI particles are promising for imaging-guided cancer diagnosis and therapy.

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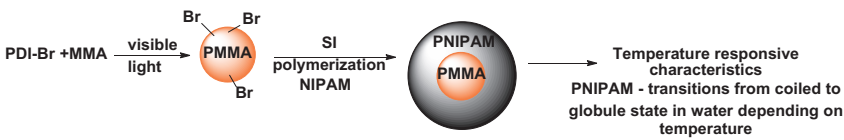
SL-36

CORE-SHELL PARTICLES WITH THERMO-RESPONSIVE WETTING CHARACTERISTICS OBTAINED BY PHOTO-MEDIATED SUSPENSION POLYMERIZATION

E. Rusen[a], F. Rizea[a], A. Mocanu[a], A. Dinescu[b], C. Stavarache[c,d], D. C. Culiţă[e], A. Diacon[a]

[a]*University Politehnica of Bucharest, Faculty of Applied Chemistry and Materials Science, 1- 7 Gh. Polizu Street, 011061, Bucharest, Romania*
[b]*National Institute for Research and Development in Microtechnologies (IMT-Bucharest), 126 A, Erou Iancu Nicolae Street, P.O. Box 38-160, 023573 Bucharest, Romania*
[c]*Advanced Polymer Materials Group, University Politehnica of Bucharest, 1-7 Gh. Polizu Street, 011061 Bucharest, Romania*
[d]*"C.D. Nenitescu" Centre of Organic Chemistry, 202-B Spl. Independentei, 060023 Bucharest, Romania*
[e]*"Ilie Murgulescu" Institute of Physical Chemistry, Romanian Academy, 202 Splaiul Indepedentei, Bucharest, 060021, Romania*
(aurel.diacon@upb.ro)

The aim of this study consisted in the synthesis and application of a perylenediimide (PDI) based photo-initiator for the fabrication of polymer particles through a photo-mediated reversible deactivation radical polymerization. The strategy involved the synthesis of a PDI derivative bearing a reactive tertiary carbon substituted with bromine which was employed in the photo-mediated suspension polymerization of methyl methacrylate. The obtained particles were subsequently used for the surface surface-initiated polymerization of a hydrophilic monomer (N-isopropyl acrylamide) to obtain a thermo-responsive shell. The core-shell morphology of the polymer particles was confirmed by SEM analysis.



Scheme 1. The polymers synthesis route.

Acknowledgement: *This work was financially supported by the project Smart polymers obtained by novel photo-ATRP and 3D printing strategies (SmartPhoto-ATRP), PN-III-P1-1.1-TE-2019-1387 (contract number TE 141/2020), financed by the Executive Unit for Financing Higher Education, Research, Development and Innovation (UEFISCDI).*

SL-37

STUDY OF THE ENCAPSULATION EFFICIENCY OF VITAMIN B1 IN ALGINATE BEADS: APPLICATION OF AN EXPERIMENTAL DESIGN

S. Benamer-Oudih, D. Tahtat, A. Nacer Khodja, M. Mahlous

Department of Irradiation Technology, Nuclear Research Center of Algiers, BP-399 Algiers, Algeria
(djtahtat@crna.dz, www.crna.dz)

The present work consisted in the synthesis of a polymeric matrix in the form of sodium alginate beads for the encapsulation of a simulant molecule (vitamin B1). An experimental design was applied to study the effect of molecular weight and alginate concentration on the encapsulation capacity of the polymeric matrix. The high and low levels applied for each factor were 71-122% for the molecular weight obtained by chain scission using gamma irradiation at dose of 20 kGy and 2-4% for the alginate concentration.
The swelling rate and cumulative release rate of vitamin B1 in gastric and intestinal simulation media were studied. The obtained alginate beads were characterized by Fourier transform infrared spectroscopy (FTIR) and scanning electron microscopy (SEM). The application of the experimental design revealed that the molecular weight of the alginate is the only factor affecting the encapsulation capacity of the beads. Indeed, the results showed that the low molecular weight alginate beads presented a better encapsulation capacity estimated at 64.87%. The experimental design allowed us to deduce the predictive mathematical model for the encapsulation capacity of vitamin B1 by the sodium alginate-based polymeric matrix.
In vitro tests showed that the swelling rate of the beads in the gastric and intestinal simulation media increased with increasing concentration and molecular weight of sodium alginate. The cumulative release rate of vitamin B1 in the gastric medium reached 88.12% after 2h and 91.13% after 24h. FTIR analysis of the encapsulated and non-encapsulated beads showed the appearance of new absorption bands due to the bonds formed between the alginate and vitamin B1. Scanning electron microscopy observation showed a dense and smooth structure with the presence of vitamin B1 on the surface of the beads which is due to electrostatic interactions between alginate and vitamin.

NOTES

POSTERS

P-01

AMPHIPHILIC BLOCK-RANDOM COPOLYMERS AS STABILIZERS IN EMULSION POLYMERIZATION

C. Sanders[a], S. Smeltzer[a], A. Werner[a], S. George[b], A. Gernandt[c], B. Reck[c], M. F. Cunningham[a]

[a]*Department of Chemical Engineering, Queen's University, Kingston, Canada*
[b]*BASF Corporation, Charlotte, North Carolina, United States*
[c]*BASF SE, Ludwigshafen, Germany*

Amphiphilic copolymers are an interesting and well-studied class of materials with highly tunable properties. A thoroughly investigated family of copolymers are those composed of styrene and acrylic acid. Random copolymers utilizing these monomers have been commercialized as polymeric surfactants (e.g. alkali-soluble resins) by a variety of manufacturers. Academia has shown interest in distinct block copolymers of styrene and acrylic acid,[1] with extensive work applying these copolymers as electrosteric stabilizers in emulsion polymerizations.[2] This work focuses on a hybrid copolymer structure composed of a hydrophobic polystyrene block complemented with an amphiphilic random block of polystyrene-r-poly(acrylic acid) with overall molar compositions between 75 and 85% polystyrene. The polystyrene-b-[polystyrene-r-poly(acrylic acid)] block-random copolymers (BRCs) have been employed as stabilizers in batch emulsion polymerization and appear to exhibit a novel nucleation mechanism.[3]

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P-02

MYRCENE THIOL-ENE MINIEMULSION POLYMERIZATION

I. L. S. Tolentino, P. H. H. Araújo, C. Sayer

Chemical and Food Engineering Department, Federal University of Santa Catarina, P.O. Box: 476, Zip Code: 88040-900, Florianópolis, Brazil (claudia.sayer@ufsc.br)

Myrcene is a terpene that has attracted much attention due to its renewable source and molecular structure with 3 double bonds with different reactivities.[1] The polymerization of myrcene by different mechanisms, including free radical, coordination, cationic and anionic polymerization was already performed.[2] Thiol-ene polymerization is a versatile route[3,4] and depending on the chosen thiol, polymers with biodegradable ester bonds may be formed. Herein, we present the photoinitiated thiol-ene polymerization of myrcene with a dithiol (2,2'-(ethylenedioxy)diethanethiol)) and a tetrathiol (pentaerythrithiol tetrakis(3-mercaptopropionate)) in miniemulsion forming sub-micrometric polymer particles. The effect of the thiol type, photoinitiator concentration and reaction time on properties as double bond conversion, molar masses, gel content, thermal behavior, zeta potential, particle size, and morphology was evaluated. Furthermore, miniemulsion polymerization results were compared to those of bulk polymerizations indicating higher conversions of the less reactive double bonds and, thus, higher molar masses and gel contents.

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P-03

POLY(2,3-DIHYDROXYPROPYL METHACRYLATE)/UPCONVERTING NANOPARTICLES VIA MINIEMULSION RAFT POLYMERIZATION

T. Vasylyshyn, V. Patsula, D. Horák

Institute of Macromolecular Chemistry, Czech Academy of Sciences, Heyrovského nám. 2, 162 06 Prague 6, Czech Republic (vasylyshyn@imc.cas.cz, www.imc.cas.cz)

Lanthanide-doped upconverting nanoparticles (UCNPs) are a new class of luminescent materials that can be used in various bioapplications. However, the usage of neat UCNPs in biomedicine is limited due to their aggregation and ion leakage resulting from particle degradation in biological fluids and buffers. Thus, the development of surface-modified UCNPs with excellent colloidal and chemical stability is crucial for application of these nanomaterials in biomedcine.

The aim of work was to prepare poly(2,3-dihydroxypropyl methacrylate)-coated UCNPs via miniemulsion reversible addition-fragmentation transfer (RAFT) polymerization. To achieve this, the uniform UCNPs were functionalized with hydrophobic penta(methyl ethylene glycol) phosphate methacrylate (Sipo) to reduce the ion leakage (Figure 1 a, b). The particles were encapsulated in poly(glycidyl methacrylate) shell via miniemulsion RAFT polymerization (Figure 1 c, d). The obtained hydrophobic polymer shell contains epoxy groups for the incorporation of theranostic agents and can be further transformed in hydrophilic one by hydrolysis.

The synthesized surface-modified multicore-shell UCNPs with diameters up to 500 nm were characterized by DLS, TEM and SEM. The presence of polymer layer on the surface was confirmed by IR and TGA.

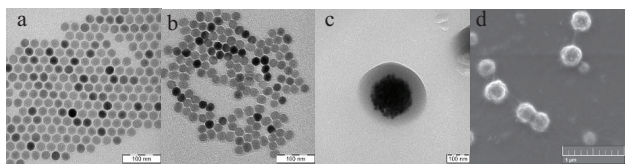

Figure 1. TEM micrographs of (a) neat UCNPs, (b) Sipo-stabilized UCNPs, and (c) poly(glycidyl methacrylate)-coated UCNPs. (d) SEM micrograph of (c).

Acknowledgement: *This work was supported by the Czech Science Foundation (21-04420S).*

P-04

EFFECT OF EPOXIDIZED SOYBEAN OIL ACRYLATION DEGREE ON THE DEVELOPMENT OF BIOBASED SYSTEM BY MINIEMULSION POLYMERIZATION

B. Perez, O. Gomez de Miranda, R. Rodriguez

TECNALIA, Basque Research and Technology Alliance (BRTA)
Paseo Mikeletegi 2, 20009, Donostia-San Sebastian, Spain
(raquel.rodriguez@tecnalia.com)

The increasing environmental regulations and public concern have driven the polymer industry to move towards more environmentally friendly processes, on that sense waterborne processes are one of the most widespread green strategies. However, these waterborne processes depend on petroleum-based chemistry which is a non-sustainable strategy. As an alternative great effort has been done searching for alternatives based on renewable resource monomers to produce novel polymers able to substitute their petroleum-based counterparts.

Among possible alternatives vegetable oils appears as a strategic option for the development of new waterborne polymers. Moreover, the use of vegetable oils in polymer synthesis is not only connected to environmental issues but also to the properties of the polymers when incorporated into the polymeric chains.[1] The principal strategy adopted for the synthesis of bio-based polymers using vegetable oils via radical polymerization involves the structural modification of fatty acids, since triglycerides present unsaturation which are not sufficiently reactive.

The objective of this work has been to synthesize new biobased monomers with different acrylation degrees based on epoxidized soybean oil and to analyze their effect of on the synthesis of biobased acrylic systems by miniemulsión polymerization process. Biobased monomers concentration degree effect (5-25wt%) has been studied showing a reduction of the polymerization rate as the acrylation degree increases, but with a high conversion degree in all cases. Moreover, the acrylation degree controls the polymer Tg, the higher the acrylation degree the higher the Tg.

Keywords: vegetable oil, acrylation degree, miniemulsión polymerization.

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P-05

ENCAPSULATION OF DYE INSIDE LATEX PARTICLES VIA POLYMERIZATION IN DISPERSE MEDIA

M. Tarhini[a], S. Khizar[a], M. Hangouet[a], G. Guignard[b], A. Hervault[b], A. Elaissari[a]

[a]Univ Lyon, University Claude Bernard Lyon-1, CNRS, ISA-UMR 5280, 69622 Villeurbanne, France
[b]CASCADE Light Technology, 12 Avenue Jacques Cartier, 44800 Saint-Herblain – France

Because of its easy operation, polymerization in disperse media has gained increasing interest with the promise of potential applications in various fields. Different dyes have been encapsulated inside polymeric latex particles via emulsion polymerization and miniemulsion polymerization. In the case of our investigated study, the encapsulation of dye is obtained by the combination of solvent diffusion of dye into polymer particles before seed emulsion polymerization using various formulations. This process has led to the progress regarding encapsulation methods to prepare latex particles to assist loading, storage, transport, as well as improving the stability of encapsulated product. Transmission electron microscopy and other elemental analysis (TGA, DCS) can be carried out to investigate successful encapsulation of dye inside the matrix matrix. The stability can be investigated in terms of thermodynamics and kinetics. During this process, the main objectives are to study the effect of presence of different cross-linkers, conversion rate of polymer, solvent diffusion and ultimately drying of the final product. The resulting latex particles are renowned as productive approach for protecting encapsulated dyes from contacts with environment in a varied range of application fields, for instance agrochemicals (e.g., controllable-release of pesticides), industrial chemicals (e.g., adhesives, paints, cosmetics, inks,), medicine (e.g., drug targeting and delivery, bioimaging), and, more recently, textiles.

P-06

POLY[*N*-(2-HYDROXYPROPYL) METHACRYLAMIDE]-BASED NANOGEL PREPARED BY DISPERSION POLYMERIZATION FOR LIVE-CELL IMAGING

P. Šálek[a], D. Zbořilová[b], E. Pavlova[a], O. Trhlíková[a], O. Šebestová Janoušková[b]

[a]*Institute of Macromolecular Chemistry, Czech Academy of Sciences, Heyrovského nám. 2, 162 06 Prague 6, Czech Republic*
[b]*Centre of Nanomaterials and Biotechnologies, Faculty of Science, Jan Evangelista Purkyně University in Ústí nad Labem, Pasteurova 15, 400 96 Ústí nad Labem, Czech Republic*
(salek@imc.cas.cz, www.imc.cas.cz)

Dispersion polymerization belongs to the group of heterogeneous polymerizations and produces various particles in diameter range from 0.1 to 15 um. Here, we present the preparation of nanogel based on *N*-(2-hydroxypropyl) methacrylamide (HPMA) and ethylene dimethacrylate (EDMA) by dispersion polymerization in water/2-methoxyethanol mixture (80/20 w/w), stabilized with poly(vinyl alcohol), and initiated with potassium persulfate. Surprisingly, the resulting P(HPMA-EDMA) nanogel had average diameter D_n = 77 nm, D_w = 97 nm, and $Đ$ = 1.26 (Figure 1a). Then, we copolymerized HPMA and EDMA with propargyl methacrylate (PMA) to obtain reactive P(HPMA-EDMA-PMA). The final nanogel possessed D_n = 68 nm, D_w = 86 nm, and $Đ$ = 1.27 (Figure 1b). The nanogel was fluorescently labeled with sulfo-cyanine3 azide and used for *in vitro* fluorescence imaging with rat mesenchymal stem cells. The results showed that the nanogel was non-cytotoxic and easily internalized in the cells.

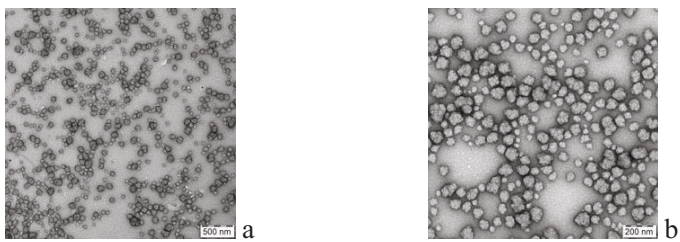

Figure 1. TEM images of poly[*N*-(2-hydroxypropyl) methacrylamide-*co*-ethylene dimethacrylate] (a) and poly[*N*-(2-hydroxypropyl) methacrylamide-*co*-ethylene dimethacrylate-*co*-propargyl methacrylate] nanogels (b).

P-07

GRAFTING STRATEGIES FOR THE SYNTHESIS OF POLYHYDRAZIDE-GOLD NANOPARTICLES

D. N. Crisan, M. Onea

National Institute of Materials Physics, Atomistilor Street, Nr. 405A, Magurele, Ilfov, 077125, Romania
(daniel.crisan@infim.ro)

Polyhydrazide scaffolds are emerging as interesting potential tools in a variety of biomedical applications such as siRNA delivery,[1] DNA condensation,[2] biofilm formation and others due to their ease of functionalization with carbonyl group containing compounds and other reactive functional groups. To further explore uses in other applications, particularly biosensors, we explored the synthesis of polyacryloyl hydrazide (PAH) grafted-AuNP. We compared three grafting strategies: "grafting-from" by introducing surface modified AuNP into the RAFT polymerization of Boc-protected acryloyl hydrazide, "grafting-to" by adding pre-synthesised polymer to citrate stabilized AuNP, and "in-situ grafting" by reducing the $HAuCl_4$ in the presence of polymer. The PAH-AuNP obtained were reacted with carbonyl containing compounds to explore their suitability towards wide-scope functionalization for future applications. Herein, we present the synthetic routes explored and characterization obtained via SEM, Raman, UV-Vis spectroscopies.

Acknowledgement: *Project BIOGOLDSURF co-fund by UEFISCDI through Development of the National System of Research Development – Post-Doctoral Research Projects 2019.*

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P-08

MICROFLUIDIC FABRICATION OF MONODISPERSE BIOCOMPATIBLE AND BIODEGRADABLE POLYMER NANOPARTICLES

A. Jäger, E. Jäger, K. L. Cavalcante, V. Sincari, E. Pavlova, M. Hrubý

Institute of Macromolecular Chemistry, Czech Academy of Sciences, Heyrovského nám. 2, 162 06 Prague 6, Czech Republic (ajager@imc.cas.cz)

Microfluidic processes using a hydrodynamic flow-focusing set-up have emerged to improve the quality of mixing of the two phases.[1] In microfluidic devices a homogeneous and fast mixing can be obtained which allows better control over the process of polymer self-assembly and also enables screening of various formulation conditions on a single platform by varying parameters such as flow rates, precursor composition, and mixing time. This work describes the preparation of polymer nanoparticles (NPs) of poly(ethylene oxide)-*b*-poly(lactic acid) (PEO-*b*-PLA) by nanoprecipitation using a three-dimensional (3D) hydrodynamic flow focusing microfluidic device. The influence of the polymer concentration and solvent (acetonitrile) to anti-solvent (water) flow rate ratios on the final particles size and dispersity (PDI) was evaluated by dynamic light scattering (DLS) and transmission electron microscopy (TEM). DLS and TEM results show that size of the produced NPs were fine-tuned in a broad range (25 to 250 nm) with a narrow size distribution (PDI < 0.15) by simple changing the polymer concentration and solvent to anti-solvent flow rate ratios. These results show that microfluidic 3D hydrodynamic flow focusing devices are emerging as powerful tools for the production of polymer NPs by nanoprecipitation.

Acknowledgement: *The authors gratefully acknowledge the Grant Agency of the Czech Republic, GAČR (grant no. 20-13946Y).*

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P-09

POLYMER NANOCAPSULES TEMPLATED ON LIQUID CORES AS A POTENTIAL NANOREACTORS

A. Medaj, J. Odrobińska-Baliś, K. Minor, A. Kmak, S. Zapotoczny

Faculty of Chemistry, Jagiellonian University, Gronostajowa 2, 30-387 Kraków, Poland
(aneta.medaj@doctoral.uj.edu.pl, www.chemia.uj.edu.pl)

Polymeric nanocapsules are efficient containers of hydrophobic and lipophilic substrates and can be formed by self-assembling amphiphilic polymers in aqueous media. These polymers stabilize particles in aqueous solution without any surfactants. Such nanosystems allow to carry out efficient and selective chemical reactions. In this regard, nanoreactions in spatially confined environments mimic processes occurring in nature.[1,2]
Physicochemical properties as well as stability of the obtained nanocapsules were examined by dynamic light scattering and zeta potential measurements. Moreover, both scanning and transmission electron microscopy indicated spherical shape and lack of aggregation of the obtained structures. The ability of encapsulation of hydrophobic compounds was examined by confocal microscopy.
The results indicate high potential of nanocapsules based on amphiphilic polymers to serve as nanocontainers and reaction chambers. Their confined environments can be used for carrying out efficient reactions.

Keywords: polymer nanocapsules, amphiphilic polymers, oil cores, nanoreactors.

Acknowledgement: *This work was financed by the National Science Centre: grant Beethoven Classic (2018/31/G/ST5/03955).*

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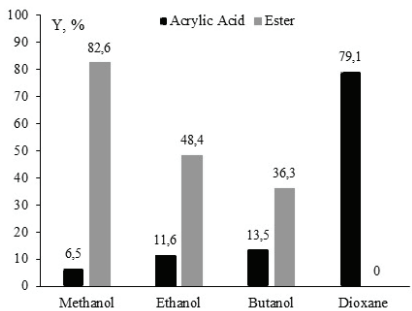
P-10

SELENIUM-MODIFIED MICROGELS AS BIO-INSPIRED CATALYSTS FOR UNSATURATED ALDEHYDES OXIDATION

R. Nebesnyi[a], T. Kharandiuk[b], A. Pavliuk[a], V. Ivasiv[a], K. H. Tan[b], A. Pich[b]

[a]Lviv Polytechnic National University, Lviv, Ukraine
[b]DWI Leibniz Institute for Interactive Materials e.V., Aachen, Germany
(roman.v.nebesnyi@lpnu.ua)

Microgels, which are porous particles embodied of crosslinked polymeric network, forming colloidally stable dispersions and swelling in water and other solvents, can be a good platform for mimicking a natural Se-containing enzymes and can be useful as the catalysts for oxidation processes. Poly(N-vinylcaprolactam) microgels modified with diselenide functional groups was synthesized by precipitation polymerization and their catalytic performance was evaluated in unsaturated aldehydes oxidation reactions with H_2O_2 as oxidant. It was confirmed that diselenide functional groups of Se-containing microgels cleave while interaction with hydrogen peroxide with further seleninic and perseleninic groups formation which are catalytically active in unsaturated aldehydes oxidation reaction. The developed Se-containing microgels were proved to be catalytically active in reactions of acrolein, methacrolein and crotone aldehyde oxidation to corresponding acids with high products yields:



Besides good catalytic activity the use of a microgel polymer support for incorporation of Se-containing catalytically active units can solve the key problem of using homogeneous catalysts for the liquid-phase oxidation of unsaturated aldehydes – allowing the catalyst to be reused in many catalytic cycles.

P-11

POLYSTYRENE-BLOCK-POLY(VINYL ALCOHOL) NANOSTRUCTURED SELF-ASSEMBLIES FOR PREPARATION OF PERVAPORATION MEMBRANES

A. Angelini[a], A. Car[a], L. Leva[b], W. Yave[b], I. A. Dinu[a]

[a]Department of Chemistry, University of Basel, Mattenstrasse 24a, BPR 1096, 4058, Basel, Switzerland
[b]DeltaMem AG, Sandweg 52, 4123 Allschwil, Switzerland
(alessandro.angelini@unibas.ch, https://meier.chemie.unibas.ch/en)

The amphiphilic block copolymers have the ability to self-assemble into well-defined nanostructures and the advantage to combine different properties arising from various structural units and functional moieties in one polymer chain. Thanks to the advances in polymer chemistry, they represent an attractive option for development of separation membranes.[1-3] However, studies on amphiphilic block copolymers with potential application in a specific industrial domain are still scarce. We present here a versatile strategy to obtain a series of polystyrene-*block*-poly(vinyl alcohol) diblock copolymers with high molecular weights that can form self-assemblies and then nanostructured membranes by casting the polymer dispersion. The domain segregation and the membrane nanoscale morphology can be simply tuned by adjusting the chemical nature of polymer blocks, their hydrophilic-to-hydrophobic length ratios and the self-assembly parameters.[4,5] This innovative approach offers the possibility to produce composite pervaporation membranes with controlled architectures and specific functionalities without adding cross-linkers or additives to circumvent the swelling. The enhanced separation performances of the nanostructured membranes for ethanol dehydration recommends them as ideal candidates for specific industrial applications.

Keywords: diblock copolymer; PVA, self-assemblies, pervaporation membranes

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P-12

CONDUCTIVE POLYMER HYDROGELS BASED ON POLY(VINYL ALCOHOL)

L. Kratofil Krehula, D. Jakus, A. Peršić, A. Kapitanović, H. Otmačić Ćurković

Faculty of Chemical Engineering and Technology, University of Zagreb, Marulićev trg 19, Zagreb, Croatia (krehula@fkit.hr, www.fkit.hr)

Hydrogels are materials with specific properties due to their composition of three-dimensional networks of crosslinked hydrophilic polymer chains and the ability to hold large amounts of water.[1] Therefore, they can be used in different fields like medicine, pharmacy, chemistry etc. In this work poly(vinyl-alcohol) based hydrogels (PVA) with the addition of sodium alginate were synthesized and characterized. PVA is a polymer with desirable properties like biocompatibility, biodegradability and nontoxicity while sodium alginate contributes to the overall quality of the prepared hydrogels due to its ability of gelling and system stabilization. If it is wanted to use hydrogels in specific applications as electrolytes for electrochemical measurements, they must possess adequate conductivity.

In this work conductive hydrogels were prepared by dissolving of PVA and sodium alginate in a dilute solution of citric acid and sodium hydroxide or in a solution of artificial rain, with or without adding glycerol. The hydrogels were synthesized by the physical method of crosslinking, which deals with freezing and thawing of the prepared solutions in repeated cycles. The hydrogels were characterized by FTIR spectroscopy and thermogravimetric analysis (TGA). The content of water in hydrogels and the degree of hydrogels' swelling in water were determined. In order to determine the conductivity and applicability of hydrogels in different electrochemical tests, the hydrogels were characterized by electrochemical impedance spectroscopy (EIS) before and after swelling in water. The results show that prepared hydrogels are conductive and with good overall properties.

Acknowledgement: *This research was supported by the Croatian Science Foundation, project number HRZZ-IP-2019-04-5030.*

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P-13

ASYMMETRIC MICROGELS BY SUPRAMOLECULAR ASSEMBLY AND PRECIPITATION POLYMERIZATION OF PYRAZOLE-MODIFIED MONOMERS

F. Grabowski[a], V. S. Petrovskii[a], F. Fink[b], S. Herres-Pawlis[b], I. Potemkin[a], A. Pich[a]

[a]DWI – Leibniz-Institute for Interactive Materials e.V., Forckenbeckstraße 50, 52074 Aachen, Germany
[b]Chair of Bioinorganic Chemistry, Institute for Inorganic Chemistry, RWTH Aachen University, Landoltweg 1a, 52074 Aachen, Germany

For the development of stimuli-responsive microgels with asymmetric shapes, we have been inspired by nature, which combines controlled chemical reactions with structure formation through supramolecular, hydrophobic and electrostatic interactions to design molecular objects with hierarchical structure, controlled shape and size. Our synthesis approach combines polymerization of pyrazole-modified monomers and self-assembly driven by supramolecular interactions. We first performed computer simulations for series of pyrazole-modified monomers with different numbers of pyrazole groups, different length and polarity of spacers between pyrazole groups and polymerizable group. These allowed us to elaborate the relationship between the chemical structure and ability to undergo π-π-stacking behavior in aqueous solutions of the monomers. The simulations clearly demonstrate a physical reason for the different microgel morphologies. On this basis, we synthesized monomers able to undergo π-π-stacking and guide the formation of supramolecular bonds between polymer segments during precipitation polymerization, leading to the formation of asymmetric microgels. We demonstrate that microgel morphologies can be tuned from spherical, raspberry-like to dumbbell-like by the increase of the pyrazole-modified monomer loading in the shell of the microgels. Therefore, our experimental data indicate that the addition mode and concentration of pyrazole-modified monomers in precipitation polymerization process allow programming the shape of microgels.

Keywords: pyrazole-modified monomers, supramolecular interactions, self-assembly, precipitation polymerization, asymmetric microgels.

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P-14

INTERNAL STRUCTURE OF HYDROGEL CONTAINING LAPONITE AND TEMPERATURE-RESPONSIVE POLY(N-ISOPROPYLACRYLAMIDE)

Y. Jeong, N. Q. Nguyen, H. Y. Cho, D. Sohn*

Department of Chemistry, Polymer Physical Chemistry Lab, Hanyang University, 222 Wangsimni-ro, Seoungdong-gu, Seoul 04763, Korea

Poly(N-isopropylacrylamide) (PNIPAM)-based hydrogels have wide applications with their unique thermo-sensitivity around lower critical solution temperature (LCST) of 32°C. NIPAM particles are highly swollen at room temperature, and particles shrink sharply when heat above the LCST. In this study, laponite-PNIPAM hydrogels were synthesized with different concentrations of clay and showed a system in which the structure changes compared to PNIPAM series and laponite series. The effect of temperature and concentration dependence by two different series were investigated.

In the swelling test, the hydrogels showed a dramatic absorbability of water. Scanning electron microscope (SEM) images confirmed the network between laponite and PNIPAM related to their swelling behavior and crosslinking density. Differential scanning calorimetry (DSC) measured the aggregation behavior of PNIPAM. Small-angle X-ray scattering (SAXS) and dynamic light scattering (DLS) experiments were performed to investigate the internal structure depending on the concentration and temperature. Internal structures of hydrogels confirmed the network between laponite and PNIPAM chains, related to their crosslinking density and swelling behavior. It is expected that could be applied to drug delivery systems that require various release conditions. Moreover, NIPAM has a LCST close to body temperature, being useful for biomedical applications.

P-15

GELATION OF STARCH POLYMER IN A HYDROGEN BOND DONOR BASED MODIFIER

T. Z. Abolibda[a*], A. P. Abbott[b]

[a]*Department of Chemistry, Islamic University of Madinah, Saudi Arabia*
[b]*Department of Chemistry, University of Leicester, Leicester, LE1 7RH, UK*
(t.z.a@iu.edu.sa)

Starch is one of the most common and easily obtained natural polymers, making it attractive as a potential bio-based alternative to synthetic polymers.[1] The plasticisation of starch is complex due to the extensive hydrogen bonding between chains. A simple quaternary ammonium salt combined with hydrogen bond donor (HBD) forms effective modifiers that produce flexible thermoplastics with good mechanical properties that are comparable to some polyolefin plastics.[2]

Mixing starch with this modifier type produces a very a homogeneous non-crystalline gel (colloid) that can be converted, by heating, from starch/modifier-gel to a rigid plastic.[3] The gelation of starch mixture with glycerol/choline chloride as the modifier was studied physicochemicaly using many techniques including: quartz crystal microbalance (QCM) and measuring the conductivity of the mixture during gelation.[2,4]

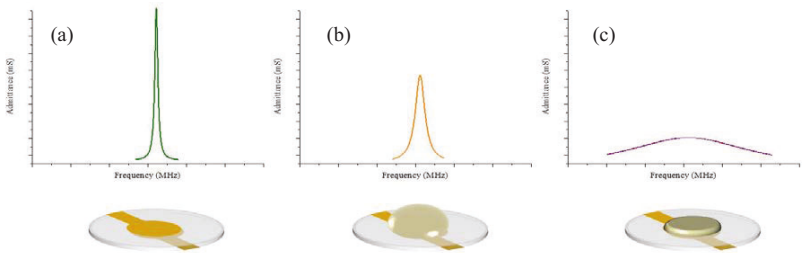

Figure 1. QCM crystal without a load (a), with the mixture before gelation (b) and after gelation (c).

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P-16

LIQUID-LIQUID AND LIQUID-SOLID SEPARATION IN SELF-ASSEMBLED POLYSACCHARIDES COMPLEXES

A. García-Jiménez, A. Román-Guerrero

Departamento de Biotecnología, Universidad Autónoma Metropolitana Unidad Iztapalapa, Av. San Rafael Atlixco 186, C.P. 09340, Ciudad de México, México (bamenginner@gmail.com)

The association of two oppositely charged macroions in solution can generate liquid-liquid separation (complex coacervates, CC) or liquid-solid separation (solid precipitates, SP).[1,2] However, the general understanding of the phase behavior between CC, SP and conversion from one state to another have not been fully elucidated.[3,4] Therefore, we analyzed the influence of pH, ionic strength, persistence length (L_p), molecular weight (M_w) and branching on chitosan-pectin (QL-Pec) and chitosan-alginate (QL-SA) phase separation behavior by turbidimetry, dynamic light scattering and phase contrast microscopy. The formation of both phases occurred simultaneously, suggesting that they follow different kinetic pathways. However, by gradually acidifying the reaction medium, it was found that these macromolecules undergo solid-liquid and liquid-solid transitions for specific pH values. Complexation was enhanced by adding 0.1 M KCl due to charge screening. In addition, the high molecular weight and branching of Pec caused the dominance of CC over SP in the QL-Pec system, and the opposite effect was observed in QL-SA. The complexation kinetics showed that under maximum interaction conditions there is a slow and gradual equilibrium between CC and SP, i.e., time is a fundamental variable during the assembly of these complexes. Our results showed that although CC and SP are formed by different kinetic pathways, the energy barrier between the two phases is small, allowing the transition from one state to the other by small changes in pH, ionic strength, or concentration.

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P-17

LUMINESCENCE ENCODING OF POLYMER MICROBEADS DURING POLYMERIZATION

L. Scholtz[a,b], J. G. Eckert[c], T. Elahi[b], F. Lübkemann[c], N. C. Bigall[c], U. Resch-Genger[a]

[a]*Bundesanstalt für Materialforschung und -prüfung (BAM), Division 1.2 Biophotonics, 12489 Berlin, Germany*
[b]*Free University Berlin, Institute for Chemistry and Biochemistry, 14195 Berlin, Germany*
[c]*Leibniz University Hannover, Institute of Physical Chemistry and Electrochemistry, 30167 Hannover, Germany*

Luminescent polymer microbeads, encoded either with organic dyes or semiconductor quantum dots (QDs), are applied in screening platforms for biomolecule binding interactions.[1] The encoding of these beads is important for the realization of optically distinguishable barcodes that can be read e.g., by a flow cytometer or fluorescence microscope. Dye encoded beads often suffer from photobleaching and can introduce difficulties due to spectral crosstalk in emission. QDs, however, absorb in a broad wavelength range and show narrow emission bands, which enables simultaneous excitation of differently colored QDs.[1] There are several challenges to be overcome for QD encoding of polymer beads. Swelling procedures in combination with premade beads often suffer from inhomogeneous QD loading, while encoding by QD addition before polymerization can result in several problems like the separation of QDs from the monomer phase or loss of QD fluorescence. This encouraged us to explore simple and effective approaches to QD encoding of polystyrene microbeads and identify suitable polymerization reactions and QD surface ligands to tackle these challenges. The best results were obtained using QDs bearing a polymerizable surface ligand dispersed in hydrophobic monomer droplets.[2] Moreover, we systematically investigated the resulting fluorescence properties of the resulting QD-encoded beads using fluorescence & integrating sphere spectroscopy as well as fluorescence & electron microscopy.

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P-18

STAR-BRANCHED POLYMERS VS. DENDRIMERS. A COMPUTER SIMULATION STUDY

A. Sikorski[a], P. Polanowski[b], K. Hałagan[b]

[a]*Faculty of Chemistry, University of Warsaw, Pasteura 1, 02-093 Warsaw Poland*

[b]*Department of Molecular Physics, Łódź Univeristy of Technology, Żeromskiego 116, 90-924 Łódź, Poland*

(sikorski@chem.uw.edu.pl)

A coarse-grained model was developed for studies of branched macromolecules. Dynamic Lattice Liquid algorithm was employed to study the synthesis of branched polymers.[1] A core-first and one-pot methodology was used in a living polymerization of stars with up to 32 arms and dendrimers consisted of 4-functional segments.[2-3] The kinetics of the synthesis process for stars and dendrimers was compared. The size and structure of colloidal spheres formed from star-branched polymers and dendrimers was also studied. The influence of functionality of well-defined cores on the structure and on the dispersity of the system was also presented.

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P-19

POLYPROPYLENE NANOPLASTICS DISPERSED IN WATER AS REFERENCE MATERIALS

J. Hildebrandt, A. F. Thünemann

Bundesanstalt für Materialforschung und -prüfung (BAM), Unter den Eichen 87, D-12205 Berlin, Germany

Plastic debris in micron and nanometer scale pollutes the nature all over the world. The potential dangers of these pollutants remain unpredictable. While risk assessment studies on microplastic are already popular, nanoplastic has not yet reached the same focus of investigation. The reason for this difference is simple: There is a "methodological gap" in the analytics of plastic particles with a diameter smaller than 1 μm.[1] Submicron and nano plastic particles are currently not detectable in environmental matrices. Therefore, it is important for researchers to have a well-characterized nanoplastic material, that serves as a reference for nanoplastic found in nature.

Our aim was to synthesize nanoplastics made from the most commonly used plastics, starting with polypropylene (PP). We found an easy way to form nanoparticles consisting of PP (nano-PP), adapting and improving the method presented for polystyrene (PS).[2] PP was dispersed to acetone and then transferred to water. No additional surfactant is needed to obtain a dispersion which is stable for more than 35 weeks.

The success of forming nanoplastics and their size was detected via scattering methods, predominantly dynamic light scattering (DLS). To examine the good stability of the nanoparticles, zeta potential measurements were performed, which revealed zeta potentials of -30 to -40 mV.

This method is repeatable and well suited to produce reference material, as which we propose our prepared particles, based on a homogeneity study, that we performed, following the ISO Guide 35[3] for reference materials.

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P-20

POLYMER PARTICLES AS CONTRAST AGENTS FOR PHOTOACOUSTIC TOMOGRAPHY

M. Paúrová[a], M. Babič[a*], I. Šeděnková[a], J. Hromádková[a], P. Matouš[b]

[a]Institute of Macromolecular Chemistry, Czech Academy of Sciences, Heyrovského nám. 2, 162 06 Prague 6, Czech Republic
[b]Charles University, First Faculty of Medicine, Center for Advanced Preclinical Imaging, Prague, Czech Republic
(babic@imc.cas.cz)

Photoacoustic (PA) imaging detects an acoustic signal induced by light. This unique method provides simultaneously ultrasound anatomical information with high resolution along with a functional photoacoustic signal, which is created by transformation of a laser pulse to mechanical wave by some light absorbing chromophore. PA imaging shows great potential for various clinical procedures from diagnosis to therapy guidance, which arises from its ability to gather functional and molecular information in real-time regime with a high spatial resolution at clinically relevant depths together with the absence of ionizing beaming.

To maximize the contrast effect of the exogenous contrast agents (CA) in the living organism, the optical absorption of the CA should be optimally in the near-infrared (NIR) regions ~700 - 1100 nm and 1200 - 2000. We developed new heterogenous syntheses of polypyrrole (PPY) particles with PA contrast properties in NIR, which allow good control of size (10 nm step within the range 80-300 nm). Besides widely used linear water-soluble polymer stabilizers of the dispersion polymerizations, classical emulsifiers were also successfully employed in their synthesis, what broadens possibilities to employ less hydrophilic comonomers in the aqueous polymerization.

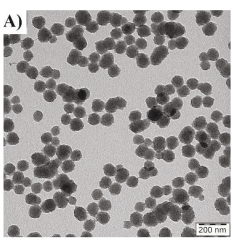


Figure: Transmission electron micrograph of polypyrrole particles prepared for photoacoustic imaging

Acknowledgement: *This work was supported by the Ministry of Education, Youth and Sport of the Czech Republic [project no. LTAUSA18173 and Czech-BioImaging LM2018129].*

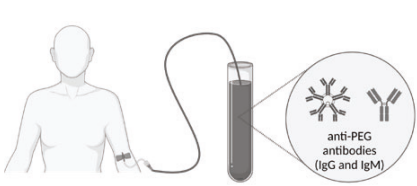
P-21

INTERACTION OF NANOCARRIERS WITH ANTI-PEG ANTIBODIES

M. Deuker, S. Morsbach, V. Mailänder, K. Landfester

Max Planck Institute for Polymer Research, Ackermannweg 10, 55128 Mainz, Germany

Currently many biomedical applications empoly poly(ethylene glycol) (PEG).[1] The usage of PEG reduces unspecific protein adsorption on nanocarriers (NC) and prolongs their circulation time. Despite this "stealth effect",[2] increasing reports demonstrate the elicitation of PEG-binding antibodies in human. Anti-PEG antibodies have been associated to an accelerated blood clearance, weakened efficacy and possible acute severe allergic reactions.[3] To become a better understanding, a detailed study of pre-existing anti-PEG antibodies in healthy individuals among the German population was performed. A high prevalence of anti-PEG IgG and IgM was found throughout the samples. Furthermore, an enrichment of anti-PEG antibodies in the protein corona of PEGylated silica nanocapsules (SiNC) compared to non-PEGylated SiNC could be observed. Additionally, the cellular uptake of PEGylated SiNC with varying amounts of anti-PEG antibodies will be monitored. The results suggest that the existence and concentration of anti-PEG antibodies in the protein corona of NC should be further evaluated to determine the potential effects *in vivo*.



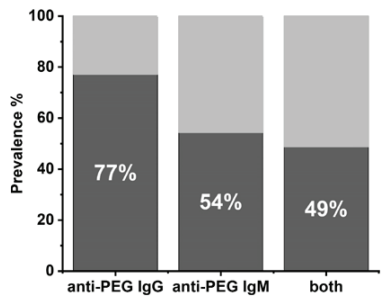


Figure 1. Plasma screening to analyse anti-PEG antibody (IgG and IgM) concentration and prevalence in a sample of the German population.

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P-22

TREHALOSE-COENCAPSULATION IN POLYMER NANOCOMPARTAMENTS FOR STABILIZING AND PROTECTING PROTEIN FUNCTIONALITY

I. A. Dinu[a,b,c], M. V. Dinu[a,c], W. Meier[a,b], N. Bruns[d]

[a]*Department of Chemistry, University of Basel, Mattenstrasse 24a, BPR 1096, 4058, Basel, Switzerland*
[b]*NCCR-Molecular Systems Engineering, Mattenstrasse 24a, BPR 1095, 4058, Basel, Switzerland*
[c]*"Petru Poni" Institute of Macromolecular Chemistry, Aleea Grigore Ghica Voda 41A, 700487 Iasi, Romania*
[d]*Adolphe Merkle Institute, University of Fribourg, 1700 Fribourg, Switzerland*
(adrian.dinu@unibas.ch, https://meier.chemie.unibas.ch/en)

Enzymes and other proteins are very attractive as therapeutics and selective biocatalysts in biomedical, industrial, chemical, and biotechnological applications.[1] However, their practical use is often limited by the low stability under harsh conditions such as desiccation, exposure to heat, light, high pressure, or pH changes.[2] Inspired by the protective mechanism of tardigrades, we demonstrate herein that trehalose, when co-encapsulated with enzymes into polymersomes, can significantly enhance the stability of enzymes. This anhydrobiotic disaccharide allowed for preserving about 81% of enzyme activity when the polymer nanocompartments loaded with enzyme and trehalose were kept for 2 months at room temperature in desiccated state and 75% of its activity when heated at 50 °C for 3 weeks.[3] In addition, the enzyme/trehalose-filled polymersomes showed a high efficiency as biocatalysts in oxidation of several textile dyes. These sugar/protein biomimetic membranes represent ideal candidates for many applications, including biosensing, environmentally friendly oxidation, or bleaching technologies.

Keywords: enzyme, trehalose, polymersomes, stability, functionality

Acknowledgement: *The KTI/CTI (now Innosuisse, Grant. No. 12980.1PFNMNM) and the University of Basel are acknowledged for financial support.*

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P-23

MAGNETIC MICROSPHERES FOR HYPERTHERMIA, DRUG DELIVERY, AND IMMUNOMAGNETIC SEPARATION

S. Dutz[a], D. Zahn[a], S. Jung[a], J. Dellith[b], K. Saatchi[c], U. O. Häfeli[c]

[a]Institut für Biomedizinische Technik und Informatik, Technische Universität Ilmenau, Ilmenau, Germany
[b]Leibniz Institute of Photonic Technology, Jena, Germany
[c]Faculty of Pharmaceutical Sciences, University of British Columbia, Vancouver, Canada
(silvio.dutz@tu-ilmenau.de, www.tu-ilmenau.de/bmti/)

Polymeric magnetic microspheres (MMS) can be used for several medical and biotechnological applications, like drug delivery, hyperthermia or immunomagnetic separation. Here, we are working on size-controlled PLGA- and PLA-MMS with embedded oleic acid coated magnetic nanoparticles (MNP), a pharmaceutical agent, and conjugated antibodies.
Microspheres were produced by an emulsion-evaporation method, where an oil phase containing polymer, MNP and drug is homogenized in an aqueous PVA phase. The solvent evaporates out of the droplets and hardened MMS result. Synthesis parameters were varied to study the tunability of the size of the MMS. For incorporating hydrophobic MNP into the MMS, we established an oleic acid coating, characterizing resulting particles with VSM, DLS and TGA. Distribution of oleic acid coated MNP in MMS was investigated with SEM on focused ion beam cross-sections of MMS. Antibody conjugation was evaluated using protein A and the biotin-avidin adsorption mechanism. Release of Camptothecin out of MMS by magnetic heating to 43 °C compared to 37 °C was investigated.
We found the MMS size to depend mainly on homogenization speed and method (mechanical or ultrasonic) and PVA concentration, leading to diameters between 0.5 and 6 µm. Oleic acid coating enables dispersion of magnetic nanoparticles in organic solvents with a mean particle diameter of 190 nm, a PDI of 0.12 and approx. 8 wt% oleic acid on the surface of the MNP. MNP are distributed homogenously throughout the spheres while maintaining a spherical shape of the MMS with MNP concentrations up to 33 wt%. Antibodies were immobilized on PLA microspheres, confirmed by optical measurements (ELISA). Drug release was increased by 30% with magnetic heating compared to passive release at body temperature.

P-24

BIOCONJUGATION OF SUPERPARAMAGNETIC NANOPARTICLES COATED WITH UNSATURATED POLYESTER

J. M. Beltrame[a], C. Guindani[a], C. Sayer[a], A. D. Zottis[b], P. H. H. Araujo[a]

[a]*Chemical and Food Engineering Department, Federal University of Santa Catarina, C.P. 476, Florianópolis – SC, CEP 88040-900, Brazil*
[b]*Department of Health and Services, Federal Institute of Santa Catarina, Campus Florianopolis, SC, 88020-300, Brazil*
(pedro.h.araujo@ufsc.br)

Superparamagnetic iron oxide nanoparticles (SPIONs) have their use approved for the detection of malignant tumors, and can be metabolized by the organism. To prevent embolism caused by these nanoparticles they need to be coated with biocompatible and non-cytotoxic materials. Synthetic polymers, like non-biodegradable poly(methyl methacrylate), have been used for this purpose. However, unsaturated polyesters obtained from lactones present several advantages over these polymeric materials, as they are not only biocompatible, but also biodegradable, and contain unsaturations in their main polymer chain, that could be reacted with different molecules,[1] such as amino acids, and their derivatives, broadening the scope of application in diagnosis, treatment, and also for theranostics. Here, we report the enzymatic ring opening copolymerization of caprolactone and an unsaturated macrolactone (globalide). The unsaturated polyester, PGlCL, was reacted with cysteine via thiol-ene reaction and the resulting polymer was used to coat the SPIONs via coprecipitation. The resulting magnetic nanoparticle coated with polyester was bioconjugated with folic acid via carbodiimide chemistry between the amine groups of bounded cysteine and the carboxylic group of folic acid featuring the active vectorization of these nanoparticles acting as nanoprobes for breast cancer.

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P-25

DESIGN, SYNTHESIS AND BACTERICIDAL ACTIVITY OF POLYMER-COATED MAGNETIC NANOPARTICLES

A. B. Shatan, D. Horák

Institute of Macromolecular Chemistry, Czech Academy of Sciences, Heyrovského nám. 2, 162 06 Prague 6, Czech Republic (shatan@imc.cas.cz, www.imc.cas.cz)

According to the clinical data, 670,000 and ~23,100 deaths occur per year globally and in EU, respectively, due to the infections caused by treatment-resistant pathogens.[1] This alarming trend has prompted the start of several programs of Global Action Plan to tackle the antimicrobial resistance, where new therapies are being to be developed. Hence, magnetic nanoparticles have received much attention due to their unique physicochemical and biological properties, such as high colloidal stability, ability to be targeted and monitored by a magnetic field, and the possibility of modification with various functional groups and biomolecules; moreover, the particles possess a high surface-to-volume ratio that increases the contact area with microorganisms.

In our study, monodisperse magnetite nanoparticles (16 nm in diameter and with dispersity $Đ$ <1.03) were prepared by a thermal decomposition of Fe(III) oleate and coated with 2-(dimethylamino)ethyl methacrylate-based polymer (PDMAEMA). The resulting polymers and/or particles were characterized by ^{1}H NMR spectroscopy, size-exclusion chromatography, transmission electron microscopy, dynamic light scattering, thermogravimetric analysis, magnetometry, or ATR FTIR and atomic absorption spectroscopy. The PDMAEMA-based Fe_3O_4 nanoparticles possessed biocidal properties against Gram-positive *Staphylococcus aureus* and Gram-negative *Escherichia coli* bacteria, which makes them an efficient and reusable antibacterial agent.

Acknowledgement: *Support of Visegrad Fund (ID # 52110952) is acknowledged.*

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P-26

CURCUMIN-BASED NANOASSEMBLIES MODIFIED WITH PROOXIDANTS FOR MAGNETIC HYPERTHERMIA

M. Świętek[a], L. Lartigue[b], T. Vasylyshyn[a], R. Konefał[a], D. Horák[a]

[a]*Institute of Macromolecular Chemistry, Czech Academy of Sciences, Heyrovského nám. 2, 162 06 Prague 6, Czech Republic*
[b]*CEISAM-UMR6230, University of Nantes, 2 rue de la Houssinière, 44322 Nantes, France*
(swietek@imc.cas.cz, www.imc.cas.cz)

Magnetic hyperthermia is characterized by better targeting cancer cells and thus lower overall toxicity compared to conventional chemotherapeutics. Combining magnetic nanoparticles (MNPs), prooxidants capable to produce reactive oxygen species only in cancer cells, and curcumin known for its antitumor effect within one platform is expected to increase the efficacy of magnetic hyperthermia in cancer therapy.

Chitosan (CS) was modified with prooxidants (artesunate, ART) via free-radical grafting. Iron oxide-based MNPs were synthesized by a solvothermal method. Both chitosan and MNPs were used for further precipitation of curcumin-based nanoassemblies. The effect of polymer and its concentration and content of ART on the morphology, stability, and magnetic properties of nanoassemblies was investigated.

MNPs showed spherical morphology (D_n=10 nm) and superparamagnetic properties. The nanoassemblies precipitated in the presence of CS-ART were polydispersed with diameter of ca. 80 nm. The higher polymer concentration and low pH, the better stability of the nanoassemblies. Larger size of nanoassemblies resulted in stronger magnetic properties.

The dependence of size and colloidal stability of nanoassemblies on pH indicated that the solubility of CS-ART played a major role during the precipitation; the content of ART had a secondary effect.

The approach proposed in this study enabled to produce CS with prooxidant properties and incorporate it into nanoassemblies to provide them ability to generate reactive oxygen species in cancerous cells.

Source(s) of research support: *The study was supported by the French Institute in Prague and the Czech Ministry of Education, Youth and Sports within Barrande Mobility programme (grant no. 8J21FR004).*

P-27

ANTIOXIDANT POLY(6-*O*-METHACRYLOYL-*L*-ASCORBIC ACID)-MODIFIED MAGNETITE NANOPARTICLES

V. Patsula, H. Macková, M. A. Świętek, V. Oleksa, D. Horák

Institute of Macromolecular Chemistry, Czech Academy of Sciences, Heyrovského nám. 2, 162 06 Prague 6, Czech Republic (patsula@imc.cas.cz, www.imc.cas.cz)

Oxidative stress is a negative phenomenon induced by imbalance between produced and captured reactive oxygen species (ROS); it leads to severe damage of DNA, proteins, and lipids, triggering cellular dysfunction and apoptosis. Therefore, oxidative stress can be responsible in the progression of atherosclerosis, cancer, cardiovascular disease, diabetes, Parkinson's and Alzheimer's diseases. Due to the ability to scavenge ROS, the antioxidants have gained a great attention as potential therapeutic agents. However, their oral intake often results in subtherapeutic concentrations at the target site. This can be overcome by the development of advanced nanocarriers that provide localized or targeted delivery of antioxidants.

In this study, uniform 18-nm magnetite nanoparticles were prepared by a thermal decomposition; they served as a core for the preparation of magnetically guided therapeutics. The newly synthetized poly(6-*O*-methacryloyl-*L*-ascorbic acid) (pMAA) was selected as antioxidant. In contrast to the highly reactive ascorbic acid (AA), its polymeric form should increase the stability and decrease the degradation, increasing delivery time. The polymer with M_n = 10 kDa and $Đ$ = 1.12 was prepared by RAFT polymerization. Its antioxidant properties were analyzed by Folin-Ciocalteu and DPPH assays; they were compared to those of neat ascorbic acid (AA). In both tests, the antioxidant activity of pMAA was lower than that for AA, confirming its higher chemical stability. To avoid reaction of the pMAA with Fe atoms, the surface of magnetic nanoparticles was covered by aminosilica shell. The pMAA was deposited on the Fe_3O_4@SiO_2NH_2 particles *via* a layer-by-layer adsorption with poly(*L*-lysine). The antioxidant-modified magnetic nanoparticles were characterized by transmission electron microscopy, FTIR spectroscopy, DLS, etc.

Keywords: magnetic nanoparticles, antioxidant, drug delivery.

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P-28

BIOLOGICAL ACTIVITY OF MULTIFUNCTIONAL NANOPARTICLES BASED ON IRON AND CERIUM OXIDES

M. Moskvin[a], I. Marková[b], V. Huntošová[c], D. Horák[a]

[a]*Institute of Macromolecular Chemistry, Czech Academy of Sciences, Heyrovského nám. 2, 162 06 Prague 6, Czech Republic*
[b]*Institute for Clinical and Experimental Medicine, Czech Academy of Sciences, Vídeňská 1958/9, 140 21 Prague 4, Czech Republic*
[c]*Center of Interdisciplinary Biosciences, Technology and Innovation Park, P. J. Šafárik University in Košice, Jesenná 5, 041 01, Košice, Slovakia*
(moskvin@imc.cas.cz, www.imc.cas.cz)

Magnetic γ-Fe_2O_3/CeO_2 nanoparticles (NPs) were obtained by basic coprecipitation of iron chlorides followed by oxidation with hydrogen peroxide and precipitation of $Ce(NO_3)_3$ with ammonia. The formation of CeO_2 seeds on the magnetic particle surface was confirmed by transmission electron microscopy, EDX and XPS spectroscopies, powder X-ray diffraction, dynamic light scattering, and elemental analysis. Also, a magnetometer was used to measure the magnetic properties of γ-Fe_2O_3/CeO_2 and to confirm their superparamagnetic nature. The surface of particles was functionalized with PEG-neridronate of two different molecular weights to ensure colloidal stability and biocompatibility. Chemical and *in vitro* biological assays proved that the NPs, due to the presence of cerium oxide, effectively scavenged radicals. Thus, levels of oxidative stress decreased in the model U87MG human glioma cells incubated with the NPs. PEG functionalization of the NPs diminished their *in vitro* aggregation and facilitated lysosomal degradation in cancer cells during autophagy, which resulted in concentration-dependent cytotoxicity of the NPs. Moreover, their ability to affect oxidative stress in hereditary hypertriglyceridemic (HHTg) rats was tested by biological tissue assay of the liver, kidney cortex, and brain. An improvement was observed in both enzymatic and non-enzymatic levels of antioxidant defense and lipid peroxidation parameters. The results corresponded with chemical determination of antioxidant activity, proving that the studied NPs effectively scavenged radicals due to the presence of cerium oxide, which decreased oxidative stress in the animal model. The particles may therefore have the potential to reduce disorders associated with oxidative stress and inflammation; at the same time, they are traceable by MRI.

P-29

ROSE BENGAL-MODIFIED UPCONVERSION NANOPARTICLES

M. Nahorniak[a], O. Pop-Georgievski[a], N. Velychkivska[a], M. Filipová[a], U. Kostiv[a,b], D. Horák[a]

[a]*Institute of Macromolecular Chemistry, Czech Academy of Sciences, Heyrovského nám. 2, 162 06 Prague 6, Czech Republic*
[b]*KTH Royal Institute of Technology, Roslagstullsbacken 21, SE-10691 Stockholm, Sweden*
(uvkostiv88@gmail.com)

Lanthanide-based upconversion nanoparticles (UCNPs) modified by a photodynamic therapy (PDT) drug (photosensitizer) have shown great promise in the cancer treatment. In this study, high-quality monodisperse UCNPs were synthesized by a high-temperature coprecipitation method, their surface was modified by Rose Bengal (RB) photosensitizer and bisphosphonate-terminated poly(ethylene glycol) (PEG).[1] Resulting RB-conjugated PEG-modified UCNPs were thoroughly characterized using TEM, DLS, TGA, FTIR, XPS, and upconversion luminescent spectroscopy. Cytotoxicity of bare and RB-conjugated UCNPs was tested on rat mesenchymal stem cells (rMSCs) showing mild cytotoxicity at the highest concentration of bare UCNPs (500 μg/ml), while RB-conjugated PEG-modified UCNPs were almost nontoxic. Generation of reactive oxygen species (ROS) from RB-conjugated PEG-modified UCNPs was tested using 9,10-diphenylanthracene under 980 nm excitation. In addition, after 10 min of near infrared (NIR) laser exposure on RB-conjugated nanoparticles ROS were produced, killing cancer cells. Hence, RB-conjugated PEG-modified UCNPs showed promise for cancer cell treatment by PDT using NIR irradiation enabling deep tissue penetration.

Acknowledgement: *The support of the Czech Science Foundation (No. 21-04420S) is acknowledged.*

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P-30

POLY(*N*,*N*-DIMETHYLACRYLAMIDE)-COATED UPCONVERTING CORE-SHELL NANOPARTICLES FOR BIOMEDICAL APPLICATIONS

V. Oleksa, V. Patsula, H. Macková, D. Horák

Institute of Macromolecular Chemistry, Czech Academy of Sciences, Heyrovského nám. 2, 162 06 Prague 6, Czech Republic (oleksa@imc.cas.cz, www.imc.cas.cz)

In this report, differently charged upconverting $NaYF_4$:Yb,Er@$NaYF_4$:Nd core-shell nanoparticles (CS-UCNPs) coated with poly(*N*,*N*-dimethylacrylamide) (PDMA) derivatives were prepared by a high-temperature coprecipitation of lanthanide chlorides in a high-boiling solvent.[1] The resulting CS-UCNPs were monodisperse and spherical (hydrodynamic diameter D_h = 28 nm and dispersity $Đ$ = 1.01). Coating was achieved by PDMA-based copolymers of *N*,*N*-dimethylacrylamide and 2-(acryloylamino)-2-methylpropane-1-sulfonic acid or *tert*-butyl [2-(acryloylamino)ethyl]carbamate, carrying sulfonate or amino groups with negative and positive charges, respectively; the copolymers were obtained by a reversible addition-fragmentation chain transfer polymerization. To ensure steric stabilization of CS-UCNPs in biological media and enable fluorescent imaging of carcinoma cells, bisphosphonate anchoring groups binding to the surface of CS-UCNPs and DY-615 dye were introduced in the copolymers. As a control, CS-UCNPs modified with two electroneutral agents, poly(*N*,*N*-dimethylacrylamide) and poly(ethylene glycol), were used. It was found that the amino-containing PDMA copolymer-coated CS-UCNPs supported engulfment in human hepatocellular carcinoma HepG2, human cervical cancer HeLa, and rat insulinoma INS-1E cells that makes the particles a suitable candidate for carcinoma cell labeling and prospectively for photodynamic therapy of various tumors.

Keywords: *N*,*N*-dimethylacrylamide, RAFT polymerization, upconversion nanoparticles.

Acknowledgement: *Support of the Czech Science Foundation (21-04420S) is acknowledged.*

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CHEMICAL AND COLLOIDAL STABILITY OF P(DMA-AGME)- AND PMVEMA-COATED UPCONVERTING NANOPARTICLES

O. Shapoval, V. Oleksa, D. Horák

Institute of Macromolecular Chemistry, Czech Academy of Sciences, Heyrovského nám. 2, 162 06 Prague 6, Czech Republic (shapoval@imc.cas.cz, www.imc.cas.cz)

Upconverting nanoparticles (UCNPs) with their multi-color emission have emerged as a promising candidate for advanced biomedical applications. One of the most important aspects of such applications deals with UCNP chemical and colloidal stability. This is often accompanied with agglomeration and/or chemical disintegration, releasing toxic rare earth ions into the surrounding media, influencing genotoxicity, and/or cytotoxicity. Therefore, we investigated the effect of surface coating of $NaYF_4$:Yb,Tm@$NaYF_4$ core-shell (CS) nanoparticles on their colloidal stability and dissolution behavior. Synthesized alendronate-modified poly(*N,N*-dimethylacrylamide-*co*-*N*-acryloylglycine methyl ester) [Ale-P(DMA-AGME)] and commercial poly(methyl vinyl ether-*alt*-maleic acid) [PMVEMA] were used as coatings to determine the colloidal and chemical stability of cylindrically shaped bare and polymer-modified CS-UCNPs in water, PBS, and Dulbecco's Modified Eagle Medium (DMEM) at 4 and 37 °C. The upconversion luminescence was determined under near-infrared excitation demonstrating ultraviolet, blue, red, and NIR emission bands of Tm^{3+}. After the incubation in water and DMEM for at least 72 h, the polymer-coated particles remained colloidally stable without significant Y^{3+} leaching. The presence of fetal bovine serum in cell growth medium increased colloidal stability of both bare and polymer-coated CS-UCNPs. PBS enhanced the release of Y^{3+} ions from the P(DMA-AGME)-Ale-coated CS-UCNPs nanoparticles. The hydrophilic PMVEMA coating rendered particles highly colloidally and chemically stable in PBS and DMEM. The application of such particles as a background-free label in single-molecule immunosensing and bioimaging is in progress.

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POROUS SILICA-BASED MAGNETIC NANOPARTICLES FOR DRUG DELIVERY

B. A. Zasońska, D. Horák

Institute of Macromolecular Chemistry, Czech Academy of Sciences, Heyrovského nám. 2, 162 06 Prague 6, Czech Republic (zasonska@imc.cas.cz, www.imc.cas.cz)

Biocompatible silica-based magnetic nanoparticles that are porous and possess unique physical and chemical properties have a great potential for biomedical applications. Such particles can be prepared with various morphologies and different functionalities. Typically, magnetic features are obtained using iron oxide nanoparticles synthesized by a coprecipitation method and coated with different shells, such as neat and functionalized silica, chitosan, poly(glycidyl methacrylate), poly(ethylene glycol), etc. For a deep understanding of the drug loading capacity, the properties of particles need to be thoroughly investigated not only regarding the particle size and dispersity, but also their surface modification and porosity, supposing that it may significantly influence the binding capacity, selectivity, and biological response. The synthesized particles were characterized by several techniques, such as scanning and transmission electron microscopy and dynamic light scattering to determine the particle morphology and hydrodynamic diameter. The presence of functional groups and chemical composition was investigated by Fourier-transform infrared and X-ray photoelectron spectroscopy. Last but not least, specific surface area, magnetic properties, and loading capacity for anticancer drug, doxorubicin, were determined.

Keywords: magnetic, particles, core-shell, surface modification, porosity.

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MAGNETIC NANOPARTICLES AS ADDITIVES TO POLYMER COMPOSITES

A. Hlukhaniuk, V. Patsula, M. Świętek, J. Hodan, B. Zasońska, D. Horák

Institute of Macromolecular Chemistry, Czech Academy of Sciences, Heyrovského nám. 2, 162 06 Prague 6, Czech Republic (hlukhaniuk@imc.cas.cz, www.imc.cas.cz)

One of the applications of magnetic nanoparticles is their use as a magnetic phase in nanocomposites intended for tissue engineering and regenerative medicine.[1] Iron oxide-based nanoparticles (IONs) are preferred due to their easy synthesis, controllable size, good magnetic properties, and biocompatibility. However, prior to their introduction into polymer, surface of IONs needs to be engineered to provide a strong interaction with polymer matrix.

IONs were synthesized by a coprecipitation method, modified with Sipomer PAM200 and ethylenediamine. ε-Caprolactone was ring-opening polymerized in the presence of particles and poly(ε-caprolactone) (PCL)-based fibrous composites were obtained by an electrospinning technique.

Superparamagnetic IONs (D_n = 11 nm) were coated with different amounts of PCL (7- 42 wt.%). The saturation magnetization of composites slightly decreased with increasing PCL content. All nanoparticles were uniformly distributed within the PCL matrix causing improvement of mechanical properties but significantly increasing toxicity, if they contained 13 or 24 wt.% of PCL. The improvement of mechanical properties of magnetic PCL-based fibers was due to strong interaction between PCL and IONs containing 13 and 24 wt.% of PCL. Hight toxicity of the composites will limit their use.

The proposed three-step modification method enabled to interaction of initially hydrophilic IONs within the hydrophobic PCL matrix. The amount of PCL on IONs determined particle-matrix interaction and was decisive for biocompatibility.

Keywords: poly(ε-caprolactone), magnetic nanoparticles, nanocomposites, biomedicine.

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P-34

A TRANSITION FROM A SPONGE-LIKE TO A FOAM-LIKE NANOSTRUCTURE IN WATER-RICH L_3 PHASES

P. Menold[a], N. Preisig[a], C. Stubenrauch[a], R. Strey[b]

[a]*Institute of Physical Chemistry, University of Stuttgart, Germany*
[b]*Department of Chemistry, University of Cologne, Germany*

Early studies[1-3] on H_2O - *n*-alkane - ionic surfactant microemulsions provide first hints for the possible existence of a foam-like nanostructure, *i.e.* a dense packing of polyhedral nanometer-sized water droplets separated by a thin layer of a continuous oil phase. We chose the system water/NaCl - hexyl methacrylate (C_6MA) - docusate sodium (AOT) for two reasons. First, because AOT is a single, pure surfactant known to form inverse structures and, secondly, our ultimate goal is to polymerize the continuous oil (C_6MA) phase, *i.e*. to synthesize genuine nano-porous polymer foams. Inspired by the pioneering work of *Skouri* et al.[4] we were able to locate an isotropic one-phase channel, the L_3 phase, emanating from the pseudo-binary system H_2O/NaCl - AOT at ambient temperature. Already upon addition of small amounts of oil to the L_3 Phase, the conductivities become very low and the viscosities very high.[5] Freeze fracture electron microscopy (FFEM) allows us actually seeing the anticipated foam-like nanostructure (see Figure 1). The structure is reminiscent of that of *Wolf* et al.[6] for a related system with a technical grade nonionic/anionic surfactant mixture. Currently, we are studying the kinetics of the oil (C_6MA) polymerization. Subsequently, the structural transition in the L_3 channel will be investigated by small angle neutron scattering (SANS) and NMR self-diffusion (FTPGSE).

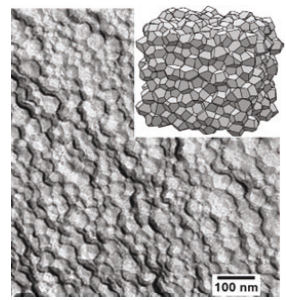

Figure 1. FFEM of the foam-like structure.[5] Scale bar = 100 nm. The inset is taken from Kravnik.[7]

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POLYANILINE-PHYTIC ACID-POLY(*N*-VINYLPYRROLIDONE) FILMS WITH CONTROLLABLE HYDROPHOBICITY

K. A. Milakin[a], U. Acharya[a], I. M. Minisy[a], D. V. Tumacder[a], Z. Morávková[a], O. Taboubi[a], T. Syrový[b,c], J. Pfleger[a], P. Bober[a]

[a]*Institute of Macromolecular Chemistry, Czech Academy of Sciences, Heyrovského nám. 2, 162 06 Prague 6, Czech Republic*
[b]*Department of Graphic Arts and Photophysics, University of Pardubice, Pardubice, Czech Republic*
[c]*Center of Materials and Nanotechnologies, Faculty of Chemical Technology, University of Pardubice, nám. Čs. legií 565, 530 02 Pardubice, Czech Republic*

Dispersion preparation and film casting are promising approaches for enhancing applicability of polyaniline and its composites. In certain areas, such as corrosion protection or supercapacitor development, controlling wettability of the films is the crucial factor responsible for the material performance. In the present work,[1] novel colloidal dispersions containing polyaniline (PANI) doped with phytic acid (PA) and stabilized by poly(*N*-vinylpyrrolidone) (PVP) have been prepared by a one-step oxidative polymerization, characterized and used for casting of transparent, uniform, conducting films with tunable hydrophobicity.

Addition of PA in the combination with varying the concentration of amphiphilic PVP allowed controlling wettability of the cast films in a wide range. At 1 wt% of PVP, PANI-PA-PVP films were hydrophobic (θ=102°), while PANI-HCl-PVP were found to be hydrophilic (θ=10°). Higher hydrophobicity of PANI-PA-PVP film was shown to be beneficial for better areal capacitance retention (97%) in comparison to PANI-HCl-PVP (61%) in supercapacitor application.

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SURFACE MODIFICATION USING MAPLE TECHNIQUE FOR IMPROVING MECHANICAL PERFORMANCE OF ADHESIVE JOINTS

V. Dinca[a], A. Mocanu[b], G. (Niță) Toader[c], E. Rusen[b], A. Diacon[b]

[a]National Institute for Laser, Plasma and Radiation Physics, Atomiștilor Street, No. 409, Magurele city, Ilfov county, RO-077125, Romania
[b]University Politehnica of Bucharest, 1-7 Gh Polizu, Polizu Campus, Bucharest, Sector 1, RO-011061, Romania
[c]Military Technical Academy "Ferdinand I", 39-49 Blvd. George Coșbuc, Sector 5, Bucharest, 050141, Romania
(alexandra.mocanu@upb.ro, www.chimie.upb.ro)

Matrix-assisted pulsed laser evaporation (MAPLE) is a thin film deposition technique that makes possible the surface modification of different substrates with organic, inorganic, biological and polymeric materials.
Here we report, for the first time to our knowledge, the deposition of two organic compounds namely polyvinyl alcohol (APV) (Mn: 124 000 g/mol) and triethanolamine (TEA) from frozen water solutions (5% by wt.) for surface modification of aluminium substrates. Aluminium plates (5 X 1 cm^2; deposition area 1 X 1 cm^2) were modified using a Surelite II pulsed Nd:YAG laser system (Continuum Company) working at a wavelength of 266 nm, with 6 ns pulse duration and 10Hz repetition rate. SEM, EDX, AFM and FT-IR were used to investigate the morphological and compositional characteristics of the aluminium and MAPLE-modified plates. The tensile strength tests proved that the uniform thin layer of TEA improved the mechanical performance of commercial monocomponent adhesive Bison Max Repair by 35.8 % compared with blank sample, while the layer of APV registered the lowest mechanical performances.

Keywords: adhesive, aluminium, surface modification, MAPLE technique.

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P-37

SYNTHESIS OF CHITOSAN NANOPARTICLES WITH CONTROLLED SIZE AND ZETA POTENTIAL: APPLICATION OF FACTORIAL EXPERIMENTAL DESIGN

S. Benamer-Oudih[a,c], D. Tahtat[a], A. Nacer Khodja[a], M. Mahlous[a], Y. Hammache[b], A. Guittoum[a], S. Kebbouche Gana[c]

[a]*Department of Irradiation Technology, Nuclear Research Center of Algiers, BP-399, Algiers, Algeria*
[b]*Nuclear Research Center of Draria, BP-43, Draria, 16050, Algiers, Algeria*
[c]*Faculty of Sciences, University M'hamed Bougara of Boumerdes, Boumerdes 35000, Algeria*
(djtahtat@crna.dz, www.crna.dz)

Optimization of chitosan nanoparticles (ChNs) production process employing a $2^{(5-2)}$ fractional factorial design was performed to analyze the influence of viscosity average molecular weight (40-120 kDa), the initial concentration of chitosan (2-5 g/L), the initial Tripolyphoshate (TPP) concentration (0.8-1.2 g/L), the ratio Chitosan/TPP (4/1-10/1)(V/V) and the stirring speed (300-700 rpm), on final nanoparticles size and zeta potential. The measured responses of average particle size and surface charge were determined on Zetasizer Nano ZS. ChNs were prepared using ionotropic cross-linking of chitosan and TPP and were characterized by FTIR, XRD and DSC.

The experiments showed that the size of synthesized nanoparticles depended on initial concentration and molecular weight of chitosan, TPP concentration and stirring speed within the chosen levels. However, the zeta potential was significantly influenced by chitosan molecular weight, chitosan concentration and stirring speed.

The FTIR analysis confirmed the interaction between negative charge of TPP with positive charge of chitosan through the appearance of new peaks at 1222 cm^{-1} and 895 cm^{-1} in produced ChNs. X-ray diffraction and DSC analysis were used to evaluate the effect of crosslinking of chitosan on crystal structure of ChNs.

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STUDY OF THE SWELLING RATE OF SUPERABSORBENT SODIUM ACRYLATE /LOCUST BEAN GUM SYNTHETIZED BY GAMMA RADIATION

D. Tahtat[a], S. Benamer-Oudih[a], A. Nacer Khodja[a], Y. Hammache[b], M. Mahlous[a]

[a]Department of Irradiation Technology, Nuclear Research Center of Algiers, BP-399 Algiers, Algeria
[b]Nuclear Research Center of Draria, BP-43, Draria, 16050, Algiers, Algeria
(djtahtat@crna.dz, www.crna.dz)

A superabsorbent based on acrylic acid (AAc) and polysaccharide was synthetized using gamma irradiation. As a polysaccharide locust bean gum (LBG) at different mass ratios was used. The blend was irradiated at doses of 8 to 12 kGy. The concentrations of LBG and NaOH were varied in order to optimize the synthesis conditions. The obtained superabsorbent was characterized by the determination of its swelling and gel rates. Swelling kinetics, gel fraction, morphological structures, FTIR analysis, thermogravimetry analysis of the superabsorbent were investigated. Kinetic studies of the swelling rates of the superabsorbent irradiated at a dose of 10 kGy shown that the concentration of 0.1 M NaOH and 1% of a low molecular weight LBG, increases and accelerates the swelling ratio which reaches after 25 min 123571%. The FTIR spectra of NaOH-AAc/LBG superabsorbent showed the presence of new absorption bands at 1550, 1051 and 1082 cm^{-1} related respectively to carboxylic acid salts (COO-) and binding of the primary alcohol C-OH of LBG.The complete miscibility between NaOH-AAc and LBG components inside the superabsorbent was confirmed by SEM micrographs. The thermograms of NaOH-AAc/LBG show endothermic peaks at 240 °C and higher exothermic peaks at 325 °C.

NOTES

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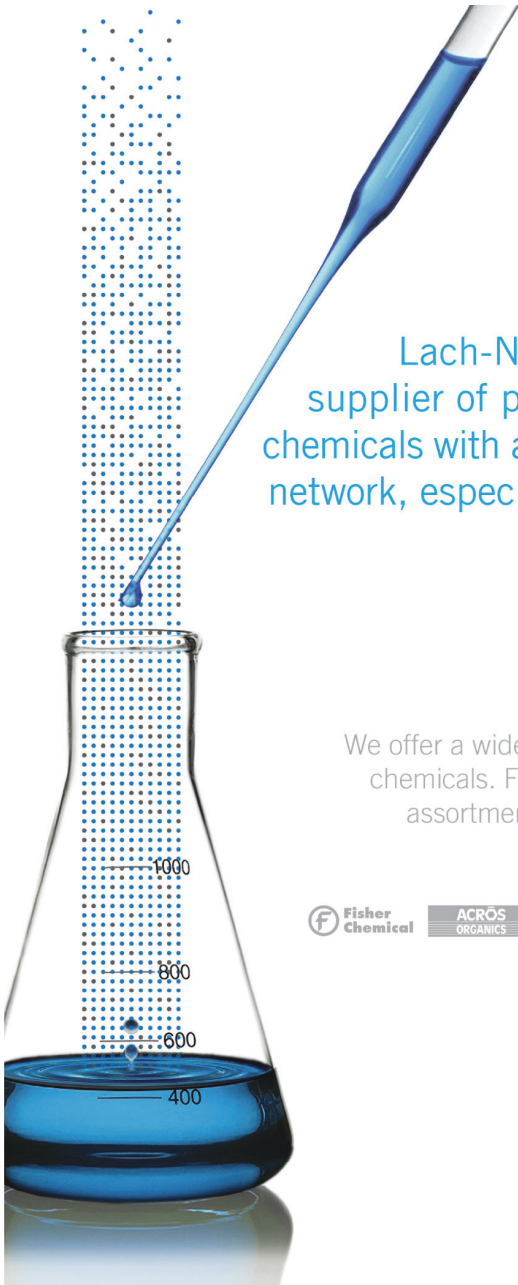

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Czech Republic

E-mail: sympo@imc.cas.cz
Website: https://www.imc.cas.cz

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Institute of Macromolecular
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Heyrovského nám. 2
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