6th French – Czech “Vltava” Chemistry Meeting

Brno, Czech Republic

August 27-28, 2015

Book of Abstracts

Masaryk University, Brno 2015
A Welcome Address from the Organizers

It is our great pleasure to welcome you to the 6th French-Czech Vltava Chemistry Meeting here in Brno. We have thus a privilege to carry on a tradition that has been launched in Dijon 2010, hearing a call from the Embassy of France in the Czech Republic, and propagated in the following years in Pardubice (2011), Dijon (2012), Prague (2013), and Gif-sur-Yvette (2014). In the meetings, scientists with common interests from both countries have got an opportunity to meet together in a more likely informal way and share their recent results, discuss interesting research topics, new projects and collaborations.

This meeting is hosted by the Department of Chemistry at Faculty of Science in the new campus of the Masaryk University keeping the well-proven scheme offering 12 plenary lectures given by invited speakers from both countries and the similar number of short oral communications in two days. All participants are very welcomed to join poster presentations. In spite of fairly busy program schedule, we believe that you will find enough of ample time for personal interactions and fruitful discussions, the most valuable aspects of such meetings.

Last but not least, let us to be grateful to our generous sponsors. Without their support the meeting would be difficult to organize.

We would like to wish all of you a scientifically and personally rewarding meeting.

The organizing committee: Miroslava Bittová
Markéta Koželouhová
Přemysl Lubal
and Ctibor Mazal

The organizers gratefully acknowledge the following sponsors:
General Information

6th French – Czech „Vltava“ Chemistry Meeting 2015 will be held in the Masaryk University Campus in Bohunice, Brno.

Address:
Kamenice 5, Brno – Bohunice
GPS: 49°10′38.0″N 16°34′02.6″E
tel.: +420 549 493 015 (secretary)

Organizers:
Department of Chemistry, Faculty of Science, Masaryk University

Lectures and Registration will take place in pavilion A11- room 132 (point A), Poster Session and Conference Party will be located in pavilion A10 and in Café On Footbridge (kavárna Na lávce) (point B). Lunches will be served in Campea Hotel (point C).

How to get the University Campus in Brno?

Destination: University Campus bus stop (Univerzitní kampus) or Bohunice Hospital bus stop (Nemocnice Bohunice) bus nr. 60 or 61, trolley bus nr. 25
Programme

Thursday, August 27, 2015

8:00 – 9:00  Registration
9:00 – 9:15  Welcome

Morning Session
9:15 – 10:00  PL1  Alexandre Martinez  (Aix-Marseille University, Marseille)
New aspect of the chemistry of hemicryptophane: from molecular recognition to supramolecular catalysis

10:00 – 10:15 OC1  Irena G. Stará  (IOCB AS CR, Prague)
Global mirror-symmetry breaking: chemical control over an enantiofacial adsorption of non-chiral molecules on a non-chiral metal

10:15 – 10:30 OC2  Ullrich Jahn  (IOCB AS CR, Prague)
Branched alkyl aryl sulfones and alkyl diaryl phosphine oxides – unusual reactivity leads to new applications

10:30 – 11:00  Coffee Break

11:00 – 11:45 PL2  Filip Bureš  (University of Pardubice, Pardubice)
Heterocyclic moieties in push-pull molecules: design, synthesis and property tuning

11:45 – 12:00 OC3  Petr Slavík  (University of Chemistry and Technology, Prague)
Intramolecular bridged calix[4]arenes as receptors for neutral compounds

12:00 – 12:15 OC4  Eva Schütznerová  (Palacky University, Olomouc)
N-oxide as an intramolecular oxidant in Baeyer-Villiger oxidation: Solid-phase synthesis of 2-alkyl-2H-indazol-3-yl benzoates

12:15 – 12:30 OC5  Ivan Němec  (Palacky University, Olomouc)
Magnetic anisotropy in pentacoordinate Ni(II) and Co(II) compounds

12:30 – 14:00  Lunch

Afternoon Session
14:00 – 14:45 PL3  Eric Doris  (CEA Saclay, Paris-Saclay)
Nanometric micelles for in vivo drug delivery and imaging

14:45 – 15:00 OC6  Jiří Pinkas  (Masaryk University, Brno)
Achieving mesoporosity in silico- and metallophosphates by non-hydrolytic templated sol-gel synthesis

15:00 – 15:15 OC7  Nikolay Vologdin  (Pierre and Marie Curie University, Paris)
Hybrid beta-lactoglobulin / prochiral palladium(II) pincer complexes systems: a new sight on artificial metalloenzymes design

15:15 – 16:00 PL4  Petr Číger  (IOCB AS CR, Prague)
Fluorescent nanodiamonds: the view from chemistry and physics sides

16:00 – 16:30  Coffee Break

16:30 – 17:15 PL5  Josef Hamáček  (University of Orleans, Orleans)
Polynuclear lanthanide assemblies as precursors for luminescent bioprobes

17:15 – 18:00 PL6  Serge Thorimbert  (Pierre and Marie Curie University, Paris)
Preparation and reactivity of original aromatic heterocycles

18:00 – 20:00  Poster Session & Conference Party
Programme

Friday, August 28, 2015

Morning Session
9:15 – 10:00  **PL7**  Petr Hermann *(Charles University, Prague)*
Complexes of macrocyclic ligands with phosphorus acid pendant arms as MRI contrast agents

10:00 – 10:15  **OC8**  Bohuslav Drahoš *(Palacky University, Olomouc)*
Bis(2-pyridylmethyl) cross-bridged cyclam – synthesis, characterization and its complexes with selected transition metals

10:15 – 10:30  **OC9**  Pavel Štarha *(Palacky University, Olomouc)*
Pharmacological perspective of anticancer active platinum(II) complexes containing 7-azaindole-based N-donor ligands

10:30 – 11:00  *Coffee Break*

11:00 – 11:45  **PL8**  Olga Iranzo *(Aix-Marseille University, Marseille)*
Tailor-made peptidic scaffolds: from biomimetic to bioinspired functionalities

11:45 – 12:30  **PL9**  Jana Hodačová *(University of Chemistry and Technology, Prague)*
A phosphate diester cleavage by artificial metalloenzymes models

12:30 – 14:00  *Lunch*

Afternoon Session
14:00 – 14:45  **PL10**  Philippe C. Gros *(University of Lorraine, Nancy)*
From Ruthenium to Iron Complexes: The Challenging Tuning of Photophysical Properties

14:45 – 15:00  **OC10**  Jiří Kozelka *(Paris Descartes University, Paris)*
Agostic and hydrogen-bonding X-H---M interactions involving a d⁸ metal center: Recent advances towards their understanding

15:00 – 15:15  **OC11**  Gaëtan L.A. Mislin *(University of Strasbourg, Illkirch-Graffenstaden)*
Synthesis of siderophore-antibiotic “Trojan horse” conjugates against pathogenic bacteria

15:15 – 16:00  **PL11**  Kamil Paruch *(Masaryk University, Brno)*
Discovery of new protein kinase inhibitors with the furo[3,2-b]pyridine core

16:00 – 16:30  *Coffee Break*

16:30 – 16:45  **OC12**  Tynchtyk Amatov *(IOCB AS CR, Prague)*
A radical approach to Asperparaline C

16:45 – 17:00  **PL12**  Viktor Kanický *(Masaryk University, Brno)*
Laser-assisted plasma spectrometry in the Laboratory of Atomic Spectrochemistry of the Department of Chemistry, MU

17:00  *Closing Remarks*
Plenary lectures
New Aspect of the Chemistry of Hemicryptophane: From Molecular Recognition to Supramolecular Catalysis

Alexandre Martinez*

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Hemicryptophanes are host molecules combining a CTV (cyclotriveratrylene) unit and another unit of $C_3$ symmetry. Although the first hemicryptophane was synthesized in 1982 by André Collet et Jean-Marie Lehn,¹ this cage molecule has received little attention during the twenty years following this first promising result. Nevertheless, since 2005 new aspects of their chemistry are developed as their use as (i) molecular receptors of carbohydrates or neurotransmitters,² (ii) molecular machines³ and (iii) supramolecular catalyst.⁴

References
Heterocyclic Moieties in Push-Pull Molecules: Design, Synthesis and Property Tuning

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Organic π-conjugated molecules attract considerable attention of organic as well as material chemists. Especially those having push-pull arrangement possess unique and peculiar properties such as dipolar character, colour, electrochemical and (non)linear optical properties [1]. Direct interaction of the electron donor and acceptor in D-π-A systems results in so-called intramolecular charge-transfer (ICT, Fig. 1) and these systems found widespread application across the fields and devices such as NLO, DSSC, OLED, OFET etc.

Fig. 1. General structure of the push-pull molecule with heteroaromatic acceptor.

In my group, several new classes of push-pull molecules of various shapes and lengths were developed to date [2]. In these derivatives, heterocyclic moieties were employed as a part of the π-conjugated path and, more often, as new heterocyclic accepting moieties. Hence, in this contribution, new heterocyclic π-conjugated scaffolds, their design, synthesis, property tuning and applications will be reviewed. Five membered imidazole, thiophene as well as six membered pyridine, pyrazine, pyrimidine etc. will be discussed. Applications of such derivatives span the nonlinear optics, two-photon absorbers, guest molecules for intercalation and photoredox catalysts.

Acknowledgements: This work has been supported by the Czech Science Foundation (13-01061S) and the Technology Agency of the Czech Republic (TE01020022, Flexprint).

References
Nanometric micelles for *in vivo* drug delivery and imaging

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Over the past few years, medicine has been a field where nanotechnologies have shown great promise particularly for diagnosis and drug delivery applications. The challenge of nanomedicine consists in carrying active molecules through the different biological barriers and reaching specific targets in an efficient and non-toxic way. In addition, some active agents require specific formulations to overcome intrinsic problems associated with aqueous insolubility, in vivo stability and bioavailability. With the advent of nanotechnologies, a whole range of new carriers with different properties and functionalities are now available. However, the development of small biocompatible carriers with high loading capacity, extended circulation time, and favourable biodistribution has several unanswered issues. This talk will give an overview of our recent findings regarding photopolymerized micelles obtained from the self-assembly of diacetylene-containing amphiphiles. Their synthesis and characterization will be presented as well as some biomedical applications such as tumour imaging and drug delivery.

**References**


Fluorescent Nanodiamonds: the View from Chemistry and Physics Sides

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Fluorescent diamond nanoparticles (FNDs) represent a key component in recent development of ultra-high precision optical resolution techniques. FNDs can accommodate nitrogen-vacancy (NV) centers – an extremely photostable crystal lattice defect emitting in near-infrared region. Electron transitions among NV quantum states can be influenced by very weak external electric or magnetic fields, which have been utilized for construction of various types of probes and nanosensors. For application of FNDs in biological systems, a precise and better control of particles’ surface and electronic properties is still required.

Different needs coming from chemistry and physics sides will be discussed and synthetic approaches towards bioapplicable FNDs will be presented. Specifically, boosting the emission intensity [1] and narrowing its distribution within the FNDs, decreasing the polydispersity of particles and shaping them to become pseudospherical [2, 3], creation of antifouling polymeric coating on FNDs and its bioorthogonal modification with various (bio)molecules using click chemistry [4], and targeting the cancer cells using these conjugates [5] will be shown. Coating of FNDs with a thin gold layer providing plasmonic nanodiamonds and application of these nanoarchitectures as highly effective opto-thermal converters in cancer thermoablation will be also discussed [6].

References
Polynuclear lanthanide assemblies as precursors for luminescent bioprobes

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Lanthanides complexes have already found applications in biological and medical research as contrast agents for MRI and SPECT. However, due to their unique luminescent properties, lanthanide-containing systems can also be employed for optical imaging in biology with near-infrared light, since biological tissue is rather transparent to light between 650 and 900 nm. This specific application requires the use of a robust luminescent probe with an optimised metal-centred emission in aqueous media.

In this context, we focus on designing new types of lanthanide-based multimetallic systems in order to collect a high visible/near-infrared light intensity. In this context, organic polyamines represent suitable precursors for constructing large polytopic ligands and platforms, which may accommodate suitable organic chromophores and metal binding moieties in a controlled way. Advantageously, amino groups can be reacted with other functional or building blocks under soft synthetic conditions.

In this contribution we present several polytopic ligands derived from polyamines (aliphatic and aromatic triamines, PAMAM dendrimers) as well as their lanthanide complexes obtained by self-assembly. We discuss different aspects of the chemical design of organic receptors (anchoring moiety, spacers) as well as structural and physico-chemical properties of supramolecular edifices (tetra-[1] penta-[2] and octanuclear[3] tetrapods, dendrimeric systems), which were recently investigated and characterized by NMR and spectroscopic techniques.

References
Preparation and Reactivity of Original Aromatic Heterocycles

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Since 2010 our team is involved in a research program focused on the synthesis and the functionalization of unknown heteroaromatic platform. In the course of our research program, we were interested in the development of the 2-substituted 4H-pyrido[e] [1,3]oxazin-4-ones which have been identified in 2009 as a new potential source of original small molecules in a list of hundred virtually generated heteroaromatic rings.[1] Through an industrial collaboration, our team has recently developed an efficient and expeditious synthesis for the construction of the bicyclic core via an unprecedent metal-free intramolecular O-arylation of N-aryl- and N-heteroaryl-isonicotinamides. [2]

A second project is dealing with dienoic carboxylic acids and their derivatives, which constitute the structural part of a number of natural products such as Macrolactin A, Rifamycin S or Fusanolide A, among other. So problem related to the synthesis of dienoic acid and control of their stereoselectivity is of great interest. We used pyrone derivatives as starting material to prepare our targets in a stereoselective manner.[3]

We will present our results and discuss our recent investigations related to these two fields of research.

Reference
Complexes of macrocyclic ligands with phosphorus acid pendant arms as MRI contrast agents

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Magnetic Resonance Imaging (MRI) is one of the most common imaging methods used in medicine and (pre)clinical research. The method follows properties (mostly NMR relaxation times) of water protons and, less commonly, also other protons or other nuclei (13C, 19F, 31P – magnetic resonance spectroscopy = MRS). To increase contrast, paramagnetic contrast agents (CA’s) are often administrated. The CA’s are the most frequently based on complexes of paramagnetic metal ions, mainly on complexes of trivalent gadolinium. Properties of the CA’s can be changed by ligand design.[1] Phosphorus acid pendant arms can finely tune these properties in the desired direction if compared with common acetic acid pendants.

Several properties (water residence time, the 2nd sphere hydration, rotation correlation time [1]) of the CA’s were improved with help of phosphonic/phosphinic acid pendants in gadolinium(III) complexes of DOTA-like ligands (Figure). It led to high relaxivity of the complexes themselves and to preparation of conjugates with several metal ions exhibiting very high relaxivity per molecule. The CA’s can be used for determination of pH if a group able to be protonated in suitable pH range is present and it can be also used to target a diseased tissue.

Fluorine-19 exhibit resonance at magnetic field very close to that where proton has the resonance. Therefore, most of modern MRI scanners can be easily tuned to measure 19F. As there is no fluorine (except bones) in human body, there is no background signal in 19F MRI. However to fully explore the 19F MRI potential, too long 19F NMR relaxation times should be shortened to just suitable values. It can be accomplished by introduction of paramagnetic ion close to the fluorine atom(s). Phosphorus acid groups were employed to put fluorine atom in the desired distance and/or to stabilize the complex. Trivalent lanthanides and, for the first time, transition metal ion were employed for the job.

Acknowledgements: We thank GAČR for financial support (grant No. P207/11/1437).

References
Tailor-made peptidic scaffolds: from biomimetic to bioinspired functionalities

Olga Iranzo*

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Peptide and peptidomimetic engineering is an expanding field of research at the crossroads between chemistry, biology, medicine and materials science. Advances in synthetic chemistry have made possible to generate many different types of well-defined or inducible tri-dimensional structures which possess attractive opportunities for the design of functional molecules. Applications in this field range from biotechnology and biomedicine (diagnostic and targeted therapy) to nanomaterials and de novo design of catalytic proteins.

We have been employing biological and chemical tools to develop robust peptide scaffolds where one can have an accurate control over the location and orientation of crucial residues for metal ion binding and/or target recognition. We are currently working on metallopeptides that are minimalistic functional models of metalloenzymes to evolve miniturized enzymes with novel tailor-made activities [1]. Cyclic peptides and linear scaffolds selectively targeting phosphorylated peptides/proteins [2] or receptors overexpressed under inflammation [3] are also being explored for therapeutic and technological applications. An overview of these data as well as recently results will be given during this presentation.

Acknowledgements: This work has been carried out with the financial support from Fundação para a Ciência e a Tecnologia (PTDC/QUI-BIQ/098406/2008, PTDC/EBB BIO/102163/2008, PTDC/QEQ-MED/2656/2012), European Commission (FP7/Marie Curie/IRG-230896), Aix-Marseille Université and Centre National de la Recherche Scientifique.

References
A Phosphate Diester Cleavage by Artificial Metalloenzymes Models

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A phosphate diester linkage is present in many biologically important compounds, such as RNA, DNA, cGMP etc., and its hydrolytic cleavage plays a crucial role in a chemistry of life. Phosphate diesters are extremely stable towards the hydrolytic cleavage at physiological pH. In nature, specific enzymes are able to accelerate the rate of hydrolysis of the P-O bond by factor up to \(10^{21}\)[1]. Over the past decades, chemists have been searching for low-molecular weight synthetic mimics of such enzymes [2]. In future, the artificial enzyme models might serve as new biotechnology tool or nucleic acid-targeting therapeutics.

A series of novel mono- and bis-polyazamacrocycles, in which the tri- or tetraazaalkyl chains are two-point connected to the rigid aromatic platform, have been synthesized. Catalytic activities of the Cu(II) and Zn(II) complexes of these ligands in the hydrolytic cleavage of 2-hydroxypropyl-p-nitrophenyl phosphate (HPNP), which serves as the RNA model, have been studied in aqueous solution at pH 7. Release of p-nitrophenol, the product of the HPNP cleavage, has been monitored by the UV-Vis spectrophotometry. Among the studied ligands, only those possessing the 2,6,10-triazaundec-1,11-diyl chain exhibited the catalytic activity. The highest acceleration of the HPNP cleavage has been observed in the presence of dinuclear Cu(II) complex of ligand 1.

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Experimental results have been complemented with theoretical quantum-chemical studies of a mechanism of the HPNP cleavage catalysed by the Cu(II) and Zn(II) complexes of 1.

References
From Ruthenium to Iron Complexes: The Challenging Tuning of Photophysical Properties

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The interest in organometallic complexes for optical applications is growing continuously. The development of such applications implies the careful design of metal complexes with appropriate photophysical properties to ensure efficient light harvesting based on strong and broadband molecular absorption or exciton generation in the condensed phase and excited state charge or energy transfer. Ruthenium polypyridine complexes have long been considered as lead compounds due to their ideal photophysical and geometrical properties. And used with success in Dye-sensitized Solar Cells (DSSCs) with efficiencies in the 9-12 % range. Our group has reported several new ruthenium complexes with improved absorption domains thanks to ligand tuning.[1] While ruthenium-based complexes have been widely investigated and used in many different lab scale applications it is a scarce metal. In contrast iron, belonging to the same group of the periodic table, is naturally abundant, of low cost and low toxicity and thus appears as an ideal substitute.

However, the replacement of ruthenium by iron is extremely challenging since in Fe-pyridine complexes an ultrafast non-radiative deactivation of the $1,3^{\text{MLCT}}$ states into the low-energy metal-centered quintuplet $5T_2$ make Fe-pyridine unexploitable for applications requiring higher free energies.

Our group has reported new carbene-based ligands for the stabilization of the $3^{\text{MLCT}}$ state in iron complexes, clearly demonstrated by means of ultrafast photophysics, together with a concomitant destabilization of the MC state. We have obtained the longest $3^{\text{MLCT}}$ state ever reported for an iron(II) complex. We have shown that several of our iron complexes can sensitize the TiO$_2$ semiconductor in a laboratory DSSC, leading to measurable photocurrent and power conversion efficiency.[2]

The conference will present our works on the preparation of ruthenium and iron complexes with focus on the chemical tuning of electronic and photophysical properties as well as their applications in DSSCs.

References

Discovery of new protein kinase inhibitors with the furo[3,2-b]pyridine core

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Development of new protein kinase inhibitors has been a very active field in the academic as well as in the industrial sector. Up to date, 30 compounds that are currently clinically used have been identified.

The central hypothesis of our project was that the furo[3,2-b]pyridine motif could serve as a proper bioisostere of the pyrazolo[1,5-a]pyrimidine pharmacophore, which was successfully used in numerous series of potent and selective inhibitors of various protein kinases.

Interestingly, only a few series of furo[3,2-b]pyridine-based protein kinase inhibitors were documented in the (patent) literature. In addition, furo[3,2-b]pyridines with NHR substituents at the 7 position, which are generally important for the interaction with the hinge regions of kinases, were not known at all.

In order to prepare initial set of furo[3,2-b]pyridines with particular substitutions patterns at positions 3, 5, 6 and 7, we optimized two known methods to assemble the furo[3,2-b]pyridine core and developed one new annulation methodology.

While some direct analogs of known pyrazolo[1,5-a]pyrimidine inhibitors proved to be less potent, the series with proper substituents at positions 3 and 5 of the furo[3,2-b]pyridine scaffold contained some very potent (IC₅₀ < 50 nM) inhibitors of CLK and HIPK kinases, which emerged only recently as possible therapeutic targets.

Of note, the activities of the most potent compounds would be hardly predictable from the available crystal structures - they would suggest that the size of the cavity would be insufficient to accommodate some “most active” substituents at position 3.
Laser-assisted plasma spectrometry in the Laboratory of Atomic Spectrochemistry of the Department of Chemistry, Masaryk University

Viktor Kanicky\textsuperscript{1,2*}, Karel Novotny\textsuperscript{1,2}, Markéta Holá\textsuperscript{2}, Michaela Vašinová Galiová\textsuperscript{1,2}, Tomáš Vaculovič\textsuperscript{1,2}, Aleš Hrdlička\textsuperscript{2}, Vítězslav Otruba\textsuperscript{1}

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Laser-assisted plasma spectrometry utilises focused radiation of pulsed lasers to produce vapours and particles by interaction with a sample. This laser ablation (LA) comprises target material ejection, melting, vaporisation, vapour condensation, coalescence of particles, dissociation, atomisation, and ionisation of both the target and ambient gas, and is accompanied by formation of a plasma plume. Aerosol produced by LA is introduced into inductively coupled plasma (ICP), where it is vaporized and free atoms are excited and ionised. Radiation emitted by atoms/ions is treated by optical emission spectrometry (OES). The LA-ICP-OES is useful for direct local/bulk analysis for determination of higher elemental contents, whereas traces are usually below limit of detection. Ions are introduced into a mass spectrometer (MS), which offers exceptional sensitivity and adequate detection limits for trace analysis. LA-ICP-MS represents a unique technique with outstanding detection capability and excellent spatial resolution, which makes it appropriate where such information is required for understanding of processes in time and space. Atoms and ions are also excited in laser-produced microplasma and the emitted radiation is processed by OES. This technique, known as laser induced breakdown spectrometry (LIBS), is less demanding as regards the cost of instrumentation. Limits of detection are higher in comparison to LA-ICP-MS, but can be improved by double-pulse technique. The LIBS requires matrix-matched calibration.

Since its beginning, Laboratory of Atomic Spectrochemistry, LAS, (Masaryk University) has been focused \textit{inter alia} on research of interaction of laser radiation with matter in terms of spectrochemical analysis of solids. As regards nature of analysed objects, research and development is involved in spatially resolved analysis of soft and hard biological tissues, such as thin sections of tumours, tapeworms and plants, teeth, urinary calculi and bones. Analysis of tissues and/or cultivated cells by LA-ICP-MS is attempted for monitoring the penetration of candidate anti-cancer drugs into cancer cells. Local microanalysis and elemental mapping of areas of interest in geological samples is performed by LA-ICP-MS and LIBS. Archaeological glass artefacts are investigated and provenance analysis of obsidian tools and raw materials is performed. Corrosion of structural alloys for nuclear industry is studied by LA-ICP-MS. Laboratory-made LIBS facility in single- and double-pulse implementation is used in the analysis of some of above materials. The LIBS facility offers promising and fast alternative to other detection techniques in detection of nanoparticles and quantum dots.

\textit{Acknowledgements: The work was supported by project CEITEC (CZ.1.05/1.1.00/0.20068).}
Short oral communications
Global mirror-symmetry breaking: Chemical control over an enantiofacial adsorption of non-chiral molecules on a non-chiral metal surface

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High-resolution AFM images of single molecules [1] provide completely new perspectives in investigation of chemical processes on surfaces [2].

Here, we report on on-surface chemistry of dibenzo[7]helicene 1 [3] deposited on Ag(111). Annealing above 100 °C has induced a [4+2] Diels-Alder cycloaddition reaction, which has triggered a cascade of chemical processes on the surface (Scheme 1). We have been able to identify an intermediate step 2 and two final products 3 and 4 by means of simultaneous AFM/STM measurements. The sharp submolecular resolution of the flat molecules 3 and 4 has been obtained using the high-resolution AFM images with a functionalised Xe-tip.

To understand the origin of an enantiofacial selectivity of adsorption, we investigated both the racemic mixture and the pure (+)-(P) enantiomer of dibenzo[7]helicene 1 deposited on the Ag(111) surface. We have found that the chiral orientation of the individual molecules as well as their complexes is driven both by chirality of helicene initially deposited on the surface and annealing conditions. We have demonstrated for the first time the chemical control over the final enantiofacial adsorption of the planar non-chiral aromatic molecules of 3 formed from the enantiopure precursor 1 on the non-chiral metal surface that has resulted in a global mirror-symmetry breaking.

Scheme 1

Acknowledgements: Supported by the Czech Science Foundation (Reg. No. 14-29667S) and IOCB ASCR (RVO: 61388963).

References
Branched Alkyl Aryl Sulfones and Alkyl Diaryl Phosphine Oxides -
Unusual Reactivity Leads to New Applications

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The chemistry of alkyl sulfones and alkyl phosphine oxides is dominated by the acidity of their α-positions, which is applied in the Julia olefination or the Wittig-Horner reactions. Here the surprising reversal of lithiation selectivity of alkyl aryl sulfones and alkyl diaryl phosphine oxides bearing different degrees of branching in the alkyl chains is reported [1-3]. Applications toward the total synthesis of cyclopentanoid monoterpenes and new phosphine ligand architectures are reported.

References
Intramolecular bridged calix[4]arenes as receptors for neutral compounds

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Calix[n]arenes, a family of macrocyclic aromatic compounds, are very popular building blocks in supramolecular chemistry due to their unique complexation properties. However, to improve the complexation properties of these receptors calix[4]arenes need to be rigidified.

During our ongoing research on calixarene derivatization we discovered an unprecedented regioselective substitution of classical calix[4]arenes leading to unique meta-substituted derivatives [1] which we used in the synthesis of intramolecularly bridged calix[4]arenes [2] These compounds not only represent a previously unknown substitution pattern in calixarene chemistry, but also can complex neutral molecules both in the solid state (X-ray) and in solution (NMR) using the cooperative effect of hydrogen bonding and CH–π interactions.

Figure 1: Preparation of bridged calix[4]arenes

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References
**N-Oxide as an Intramolecular Oxidant in Baeyer-Villiger Oxidation: Solid-Phase Synthesis of 2-Alkyl-2H-indazol-3-yl benzoates**

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2-Nitrobenzenesulfonylchloride (2-Nos-Cl) and 4-nitrobenzenesulfonylchloride (4-Nos-Cl) were introduced as effective protecting/activating groups for the regioselective N-monoalkylation of primary amines by Fukuyama.¹ Apart from that, 2-Nos-Cl can also serve as an advantageous building block that can be effectively incorporated into the synthesis of heterocycles. While developing combinatorial libraries of drug-like heterocyclic compounds, our group observed an unprecedented difference in the reactivity of 2- and 4-Nos derivatives. By treatment with the conventional cleavage cocktail of mercaptoethanol/DBU, 2-Nos derivatives underwent the intramolecular C-arylation followed by N-N bond formation resulting in indazole oxides.² The original tandem reaction was extended, when we discovered a new ring-expansion of the indazole oxides substituted with an acidic proton leading to quinazolines.³ We present 2-Nitrobenzenesulfonamides as advanced intermediates that can be converted into benzothiadiazepines,⁴ benzothiazines⁵ and indoles.⁶ This contribution describes further extension of the tandem C-C followed by N-N bond formations for preparation of indazolyl benzoates. Formally, the transformation includes the Baeyer-Villiger oxidation of ketones to esters.

![Diagram](https://via.placeholder.com/150)

**L**: Wang linker

**References**

Magnetic anisotropy in pentacoordinate Ni(II) and Co(II) compounds

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Coordination compounds exhibiting magnetic bistability attract a lot of scientific attention due to their possible utilization in industrial applications such as molecular switches in quantum computing, displays or magnetic memories with high-density storage. The most promising magnetically bistable materials are the compounds exhibiting slow-relaxation of magnetisation on a molecular level – so called single-molecule magnets (SMMs). In these, the uniaxial magnetic anisotropy (characterized by the negative axial zero-field splitting parameter $D$) results in the formation of spin reversal barrier which is the origin of the slow-relaxation of magnetisation. Therefore, the knowledge of the influence of the selected structural parameters (e.g. chromophore bond lengths and angles, distortions from ideal shape of coordination polyhedron…) on the sign and value of the $D$-parameter is crucial for design of new SMMs.

In this presentation we report on an extensive study conducted on pentacoordinate compounds with $\{\text{MN}_3\text{X}_2\}$, $\{\text{MN}_5\}$, $\{\text{MN}_4\text{O}_1\}$, $\{\text{MN}_3\text{O}_2\}$, $\{\text{MN}_2\text{O}_3\}$, $\{\text{MN}_1\text{O}_4\}$, $\{\text{MO}_5\}$ and $\{\text{MN}_2\text{OX}_2\}$ chromophores, where X stands for halido ligands, M = Ni(II) or Co(II). The presented compounds were subjects of experimental (SQUID magnetometry, HF-EPR) and theoretical ($ab\text{ initio}$ calculations) investigations. For the Ni(II) compounds the linear magneto-structural relationship [1] between $D$ and $\tau$ ([2]) was established and it was revealed that the Ni(II) compounds with the chromophore geometry close to ideal square pyramidal ($\tau$ close to 0) adopt large and positive $D$ values, while the compounds with trigonal bipyramidal geometry ($\tau$ close to 1) adopt large and negative $D$ values. In the Co(II) compounds, the relation between $D$ and $\tau$ was found to be opposite ($\tau$ close to 0 $\rightarrow D << 0$, $\tau$ close to 1 $\rightarrow D >> 0$). The study of dynamic magnetic properties revealed several new mononuclear field-induced Co(II) SMMs but no slow-relaxation of magnetization was observed for mononuclear Ni(II) compounds.

Acknowledgements: We gratefully thank Grant Agency of Czech Republic (13-27355P) and NPU I (LO1305) for financial support.

References
Achieving mesoporosity in silico- and metallophosphates by non-hydrolytic templated sol-gel synthesis

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Materials possessing stable porosity with pore diameters above 2 nm are important in many areas of chemistry and technology. Sol-gel methods are attractive routes to porous multimetallic oxides and inorganic-organic hybrid materials. Alternatives to classical aqueous sol-gel techniques are non-hydrolytic condensation reactions. We developed non-hydrolytic sol-gel procedures based on elimination of trimethylsilyl ester of acetic acid $[1,2]$ or dialkylacetamide $[3,4,5]$ elimination providing silicophosphates and Al, Ti, and Zr silicates, respectively. The polycondensation reactions between silicon acetate $\text{Si(OAc)}_4$ and $\text{OP(OSiMe}_3)_3$ lead to microporous xerogels with high surface areas and octahedrally coordinated Si atoms $[1]$. Bis-acetoxyisilanes with bridging groups provide hybrid xerogels with significant mesoporosity $[2]$. The synthesis of mesoporous nanocrystalline $\text{Si}_5\text{P}_6\text{O}_{25}$ is achieved with Pluronic P123 template followed by calcination in air. Metal amides $\text{M(NR}_2)_n$ ($\text{M} = \text{Al, Ti, Zr}$) in acetamide elimination reactions with $\text{Si(OAc)}_4$ provide metallosilicate xerogels with a high content of Si–O–M bonds but relatively low surface areas $[3]$. Their porosity is lost upon calcination. However, with addition of Pluronic P123 as a structure directing agents, mesoporous metallosilicate materials with large surface areas (up to 615 m$^2$ g$^{-1}$) and well dispersed tetrahedral metal atoms are obtained. They are stable at temperatures up to 500 °C and show superior catalytic activity and selectivity in various catalytic reactions $[4,5]$. The prepared xerogels were characterized by solid-state $^{13}\text{C}$, $^{27}\text{Al}$, $^{29}\text{Si}$, $^{31}\text{P}$ NMR, IR, surface area analysis, DRUV-vis, TGA and XRD.

Acknowledgements: Authors thank CEITEC - CZ.1.05/1.1.00/02.0068 and KONTAKT LH11028.

References
Hybrid $\beta$-lactoglobulin/prochiral palladium(II) pincer complexes systems: a new sight on artificial metalloenzymes design

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Artificial metalloenzymes is one of the modern and attractive approaches to stereoselective catalytic transformations.$^1$ These are hybrid species which contain a catalytically active transition metal complex incorporated within a host biomacromolecule, typically a protein, peptide or DNA.$^{2,3}$ Earlier one of us reported synthesis and study of catalytic activity in enantioselective transfer hydrogenation of hybrid systems, based on Ru(II) and Rh(III) half-sandwich complexes incorporated into $\beta$-lactoglobulin ($\beta$-LG) and papain.$^{4,5}$ The results of this work encouraged us to continue the research in this field. Now, our approach consists in the utilization of transition metal complexes based on prochiral hemi-labile ligands, since host molecule could force them to adapt the specific stereoconfiguration. This makes possible to bring the chirality closer to the catalytic metal center and, therefore, to increase enantioselectivity of catalyzed reactions.

In this contribution, we report synthesis of new NCN pincer palladium(II) complexes with prochiral hemi-labile ligands. The study of their structural properties and macromolecular anchoring with $\beta$-lactoglobulin ($\beta$-LG) will be also discussed.

![Diagram of NCN pincer palladium(II) complexes](image)

References

Bis(2-Pyridylmethyl) Cross-Bridged Cyclam – Synthesis, Characterization and its Complexes with Selected Transition Metals

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Among the tetraazamacrocycles called ethylene cross-bridged cyclams modified with pendant arms containing pyridine moiety, a new derivative of bis(2-pyridylmethyl) cross-bridged cyclam (L, Figure 1), has been synthesized using Weisman’s approach, i.e. dialkylation of cyclam bisaminal with 2-chloromethylpyridine followed by double reductive ring expansion using NaBH₄ (Figure 1) [1]. The low yield of the preparation was caused by a number of observed side-reactions. The pH-NMR titration confirmed the proposed proton-sponge behaviour of the ligand (pK₁ > 12) and revealed other two pK₂ = 8.59 and pK₃ = 0.46. The coordination ability of L was studied on selected transition metals – Cu²⁺, Mn²⁺ and Fe²⁺. Whereas the Cu²⁺ complex was formed even with the diprotonated ligand, the complexes of the two later metals were prepared under inert atmosphere using L in strictly deprotonated form of free base. Now, these compounds are still under investigation and thus, their molecular structures and magnetic and redox properties will be discussed within the framework of the presentation. Nevertheless, preliminary results of dissociation kinetics of the Cu²⁺ complex showed its low kinetic inertness in acidic media in comparison with Cu²⁺ complexes with structurally similar cross-bridged cyclams [2].

![Scheme showing the synthesis of bis(2-pyridylmethyl) cross-bridged cyclam L.](image)

References
Pharmacological perspective of anticancer active platinum(II) complexes containing 7-azaindole-based N-donor ligands

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Various platinum(II) complexes containing 7-azaindole-based N-donor ligands (naza) and differing in the type of the leaving group have been recently investigated by our team. The main objective of this research was to develop pharmacologically prospective anticancer active platinum(II) complexes, which would exceed the antiproliferative effect of clinically used platinum-based anticancer drugs, and show i) lower negative side effects and ii) ability to overcome intrinsic and/or acquired resistance of various tumour types against the clinically used anticancer therapeutics. We prepared several types of complexes of the general formulas cis-[Pt(naza)\(_2\)X\(_2\)] and [Pt(naza)\(_2\)Y], which were fully characterized by various techniques including multinuclear NMR spectroscopy (\(^1\)H, \(^{13}\)C, \(^{15}\)N and \(^{195}\)Pt) and a single-crystal X-ray analysis; X = Cl\(^–\), I\(^–\) or decanoate; Y = oxalate, malonate, cyclobutane-1,1-dicarboxylate) [e.g. 1–4]. Most of the prepared complexes exhibited higher in vitro cytotoxicity against various human cancer (e.g. cisplatin-sensitive A2780 and -resistant A2780R ovarian, MCF7 breast, HOS osteosarcoma or LNCaP prostate) cell lines, as compared with clinically used platinum-based anticancer drug cisplatin. The dichlorido and diiodido complexes were also studied for their in vivo antiproliferative effect against L1210 leukaemia cell line on mice, where especially the dichlorido complexes showed activity comparable with cisplatin, but were found as less toxic to healthy tissues than cisplatin resulting in longer survival time of the treated animals. The mechanism of action was studied in detail by various chemical (\(^1\)H NMR and ESI-MS studies of hydrolysis and interaction with mechanistically relevant biomolecules, such as GSH or GMP) or molecular pharmacological (cellular accumulation, DNA platination, cell cycle perturbation studies by flow cytometry etc.) methods. Moreover, these substances showed high selectivity against cancer cells, because no biological effect against non-cancerous primary cultures of human hepatocytes was found up to the concentration of 250.0 \(\mu\)M.

References
Agostic and hydrogen-bonding X-H···M interactions involving a d⁸ metal center: Recent advances towards their understanding

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The binding of d⁸ transition metal ions to X-H bonds (X = non-metal) has been subject of intense research in the last two decades. Two different types of orbital interactions can stabilize X-H···M bonds: i) charge transfer from a filled orbital of the metal into the empty σ*-antibonding orbital of the X-H bond; ii) charge transfer from the filled σ-bonding orbital of the X-H bond into an empty orbital of the metal. The first type corresponds to a hydrogen bond, whereas the second is commonly designated as an agostic bond. The present lecture analyses experimental and theoretical approaches to the characterization of these two interaction types in d⁸ transition metal complexes, points out some assignment errors that occurred in the past, and summarizes recent advances towards the understanding of the structure, dynamics, and physical origin of these weak interactions [1]. A neutron-diffraction structure of the neutral platinum complex trans-[PtCl₂(NH₃)(N-glycine)]·H₂O displaying two non-classical hydrogen bonds to Pt(II) as acceptor [2] (Figure) will receive particular attention.

References
Synthesis of siderophore-antibiotic “Trojan horse” conjugates against pathogenic bacteria

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Antibiotic resistant infections are major concerns for public health authorities. Thus, the discovery of new therapeutic strategies is necessary to regain upper hand on pathogenic bacteria. Iron is crucial for almost all microorganisms. Pathogenic bacteria have developed efficient pathways to acquire iron from their host or from environment. One of these systems is based on iron chelating molecules called siderophores, excreted in extracellular medium by bacteria [1]. Ferric-siderophore is imported into the bacterial cell by a multiproteic system. This uptake pathway is a selective gate across the bacterial envelope. “Trojan horse” conjugates between antibiotics and siderophores can use iron uptake systems to circumvent the low permeability of bacterial membranes and increasing the antibiotic activity [2].

We synthesized two vectors 3 and 4 based respectively on pyochelin 1 and aminochelin 2 siderophores [3]. These vectors, bearing a terminal alkyne group, has been further conjugated to azide antibiotics using “click chemistry” promoted by Cu(I). In resulting conjugates 5 and 6, vectors and antibiotics are connected through an 1,2,3-triazole linker. In this context, the vectorization of different families of antibiotics is under investigation using this strategy.

Resulting conjugates 5 and 6 have been tested, and compared to the free antibiotic, for their antibiotic activities on Pseudomonas aeruginosa, a pathogenic bacterium responsible of severe lung infections in immunocompromised and cystic fibrosis affected patients. For some of these conjugates, MICs are significantly higher than the free antibiotic.

References
A Radical Approach to Asperparaline C

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The superfamily of bridged diketopiperazine (DKP) alkaloids, containing the central bicyclo[2.2.2]diazaoctane core structure, has been fascinating chemists for almost half a century. According to a recent review, nearly 70 secondary metabolites containing the bicyclo[2.2.2]diazaoctane ring system have been isolated to date[1].

The asperparaline family, isolated from Aspergillus japonicus JV–23 in 1997 and consisting of asperparalines A, B and C contain an unusual and challenging 3-spiro-succinimide unit [2]. They have been shown to have potent paralytic activities against insects and recent studies aimed at elucidating their mechanism of action showed that asperparaline A strongly and selectively blocks insect nicotinic acetylcholine receptor (nAChR) [3]. Despite several published studies aimed at their total synthesis, asperparalines defy successful synthetic efforts.

Reported herein will be a novel approach to asperparaline C using the tin-free radical reactions as the key steps:

References
Posters
Synthesis and biological evaluation of new potent pyrazolo [1,5-a] pyrimidine inhibitors of CDK2 designed using a quantum mechanics (QM)-based scoring function

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The serine/threonine kinase CDK2 (member of the cyclin-dependent kinase family) is of considerable interest as a potential drug target in oncology owing to its important role in the regulation of the mitotic progression and its association with the molecular pathology of cancer. 1,2,3 As a consequence, small-molecule ATP-competitive CDK inhibitors have potential therapeutic value as antitumor agents. 4 Furthermore, despite the fact that structures of many protein kinases have been characterized by X-ray crystallography, molecular modelling and in-silico prediction of new sub-micromolar kinase inhibitors still remain a significant challenge. 5

Recently, we successfully applied a refined quantum mechanics (QM)-based scoring protocol to recapitulate the binding affinities of known pyrazolo[1,5-a]pyrimidine inhibitors of CDK2 kinase and their bioisosteres. 6 Utilizing the same scoring function, novel inhibitors bearing properly substituted biphenyls at the 5-position of the pyrazolo[1,5-a]pyrimidine core were modelled. The synthesis and biological evaluation of these new CDK2 inhibitors will be discussed in order to assess the predictive power of the in-silico methodology.

References
Synthesis of optically pure helically chiral 2-amino helicenes as precursors for NHC ligands

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N-Heterocyclic carbenes (NHC) as one of the most successful ligands have been widely used in catalysis with late transition metals due to their strong σ-donating properties [1]. These types of carbenes are generated in situ from the corresponding azolium salts prepared from primary amines. Helicenes are the vast polycyclic aromatic systems with helical chirality, which have been so far rarely used in the enantioselective catalysis. Recently, we have published a reliable method for the preparation of optically pure heterohelicenes with 2H-pyran structure based on diastereoselective [2+2+2] cyclotrimerization of centrally chiral substituted aromatic triynes catalyzed by complexes of Ni(0) or Co(I) [2].

Here, we report on the synthesis of 2-amino[5]- and [6]helicenes 4 as the new type of NHC ligand precursors. In their synthesis, the key building blocks (R,R)-3 were prepared by a sequence of Sonogashira coupling/Mitsunobu reaction and the diastereoselective [2+2+2] cyclotrimerization provided the helically chiral amines (M,R,R)-4 with >99% de. In the following steps, the corresponding imidazolium salts (M,R,R)-5 and (M,R,R)-6 as the NHC ligands precursors were prepared. These imidazolium salts are being tested in the enantioselective catalysis.

Scheme 1

Acknowledgements: Supported by the Czech Science Foundation (Reg. No. 14-29667S) and IOCB ASCR (RVO: 61388963).

References
The Stereoselective Self-Assembly of Chiral Metallo-Organic Cryptophanes

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Cryptophanes are macropolycyclic cyclophanes made from two triply-bridged concave cyclotriveratrylene analogues (CTV) that can encapsulate various molecular (alcanes, quaternary ammoniums) or monoatomic (Cs+, Xe) substrates.[1] They are generally obtained by multistep organic synthesis as separable mixtures of meso and chiral diastereomers. Rare are examples of cryptophanes obtained by metal-directed self-assembly.[2,3]

Inspired by the work of Dalcanale and coworkers on resorarene-based molecular capsules,[4] we report here the self-assembly of cryptophanes based on the M–N bond (M = Pd or Pt) from nitrile-functionalized CTVs. The metallo-organic cryptophanes formed in chlorinated solvents (C₂D₂Cl₄, CHCl₃, and CH₂Cl₂) at room temperature quantitatively and stereoselectively, the chiral anti diastereomers being observed in solution and in the solid state, but in the case of Pt, the latter were accompanied by ca. 5% of the achiral syn diastereomer. Interestingly, variable temperature studies in CD₂Cl₂ showed that, in the case of the Pd-based metallo-organic cryptophane, the major component switched to the meso form at low temperature.

The X-ray crystal structures of the Pd- and Pt-based metallo-organic chiral cryptophanes showed that they encapsulated a chloroform molecule, with the intriguing feature that the C₃ symmetry axis of the latter was not coincident with the pseudo-C₃ symmetry axis of the metallo-organic cryptophane, unlike neutral organic analogues.[5] This was interpreted by considering the unsymmetrical distribution of the triflate anions in the crystal. However, in spite of the fact that the occupancy factor was close to the ideal value of 0.55, the included CHCl₃ molecule could not be detected in solution, even at low temperature.

Dynamic combinatorial chemistry experiments were conducted by using palladium as assembling metal and two different nitrile-substituted CTVs. They showed that, whatever the starting compounds used (either a 3:1:1 mixture of [Pd(dppp)]²⁺ and the CTVs or a 1:1 mixture of the preformed trinuclear complexes), no heteroleptic metallo-organic cryptophane was formed, pointing to a self-sorting process.

References
A Novel Approach to Quinazoline Alkaloids

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The quinazoline family of alkaloids, having diverse biological activities, is a growing class of secondary metabolites.\[1\] Biosynthetically they are made from tryptophan and anthranilic acid by incorporation of an additional amino acid unit. The members of this class of alkaloids exhibit cytotoxic, antiviral and anti-multidrug resistance activities. As such, practical methods that allow rapid access to large quantities of these alkaloids and their analogs are needed.

Reported herein will be an approach to quinazoline derivates using silicagel mediated double condensation. This method was successfully applied to the synthesis of glyantrypine and progress toward ardeemin will be reported.

![Chemical structures of Glynantypine, Fumiquinazoline F, and Ardeemin with reaction conditions](image)

References

Synthesis of new carbocyclic C-nucleoside analogs

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Classical nucleoside analogs (A) include a variety of biologically active compounds, namely those with antiviral and anticancer properties [1]. Since they possess the hemiaminal motif, their chemical and metabolic stability is therefore often limited and the resulting metabolites can be the source of undesired side effects. Significant effort has thus been invested into the identification of more stable substances while preserving the biological activity, e.g. C-nucleosides (B) or carbocyclic N-nucleosides (C).

It is conceivable that, at least in some cases, carbocyclic C-nucleosides (D) might be even more robust versions of nucleoside analogs B and C. In addition, installation of certain substituents (e.g. R1 = OH) is meaningful only in this class, as this would lead to chemically unstable ketals and aminals in the series A, B and C. However, analogs D are quite rare and most published syntheses only produced single target compounds [2].

Our recently developed flexible synthesis of compounds D enables selective manipulation of individual positions around the cyclopentane ring, including highly diastereoselective installation of substituents R1 and R2.

References
Pyridodibenzo[5]-, [6]-, and [7]helicenes via cyclotrimerization of diynenitriles

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Helicenes, unique helically chiral polycyclic aromatic molecules with extraordinary physicochemical properties, have been attracting attention since the beginning of the 20th century [1]. Recently, we have developed an efficient way to fully aromatic dibenzohelicenes, which enables their synthesis in three to five steps from commercially available materials [2]. Based on this methodology, we report here on the preparation of pyridodibenzo[5]-, [6]-, and [7]helicenes (Fig. 1).

Figure 1

The key intermediates for an intramolecular [2+2+2] cyclotrimerization of two alkyne units with a nitrile one [3] to pyridine derivatives were prepared by palladium catalyzed Sonogashira and Suzuki-Miyaura cross-couplings (Scheme 1).

Scheme 1

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References
Solution study of chemical equilibria of adenine-like ligands

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Nucleobases are building blocks of nucleic acids (DNA, RNA) playing role in the transfer of genetic information [1]. Some structurally modified nucleobases and nucleosides exhibit physiological activity and therefore they are used as drugs.

This contribution is focused on the study of protonation constants of adenine-like compounds. They were determined by means of molecular absorption spectroscopy in UV region (I = 0.15 mol.l⁻¹ M NaCl, t = 25 °C) and the experimental data were evaluated by OPIUM program. In addition, the temperature and ionic-strength dependence of protonation constants of studied ligands was used to estimate thermodynamic parameters (ΔH°, ΔS°, protonation constant(s) for infinite dilution). Some examples of ligand complexation by Zn(II) metal ion will be presented and their importance for bioligand speciation in vivo will be discussed.

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References
Uranyl uptake properties of desferrioxamine B and related compounds

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Siderophores are ubiquitous, high-affinity iron(III) chelators excreted by virtually all bacteria and yeasts under iron-stress conditions. Their primary biological role is to supply the microorganisms with iron, an essential nutrient and growth factor. As a mean to circumvent the extremely low bioavailability of this element at physiological pH, siderophores react with ferric (oxo)hydroxides and form thereby water-soluble complexes which are transported across the cell membranes according to an energy-driven mechanism involving specific outer-membrane uptake receptors. Hydroxamates are common bidentate chelating groups found in many siderophores, an emblematic representative being desferrioxamine B.

As the concentration of desferrioxamine in soils is typically in the µg/kg range, it might significantly increase the solubility, migration rate, and bioavailability of highly-toxic actinides in case of environmental contamination. It is therefore of utmost importance to gain a deeper understanding of their f-element coordination chemistry, in relation to the management and remediation of contaminated fields, or disposal of nuclear wastes in geological repositories. However, predicting and modeling the metal speciation in waters and soils requires an accurate knowledge of the thermodynamic and kinetic parameters related to the complex formation and dissociation equilibria. Because such data are scarce and often unreliable in the case of the transuranium cations, considerable research efforts are still required.

By combining potentiometric and spectrophotometric titration techniques with capillary zone electrophoresis, the speciation of linear and cyclic monohydroxamates, abiotic dihydroxamates, and desferrioxamine B in the presence of uranyl could be unraveled. X-ray absorption and Raman spectroscopies enabled to probe the chemical environment around the uranium center in the different species prevailing in solution. Finally, the proton-assisted step-by-step dissociation mechanism of the [UO₂(DFB)H₅]⁺ complex, as established by stopped-flow spectrophotometry, will be presented.
Effect of alkali metal ions on dissociation kinetics of Cu(II) complexes of DOTP-like macrocyclic ligands

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Tetraaza-macrocyclic ligands based on cyclen skeleton are well known for their ability to bind Cu(II) ion leading to formation of metal complexes of high thermodynamic stability and kinetic inertness which are required for their in vivo applications and in medicine [1–3]. Some complexes of copper radioisotopes are utilized in diagnosis (positron emission tomography - PET, 64Cu with half-life 12.8 h) or in radio-immunotherapy (67Cu with half-life 62 h) [4]. In addition, the sodium and potassium ions play an important role in biology, e.g. concentration gradient of sodium/potassium ions is important in living organism for many cell functions, and their presence in the solution can affect the kinetic inertness of Cu(II) complexes.

In this work, the acid-assisted dissociation kinetics of Cu(II) complexes with DOTP-like ligands (e.g. H6do3p, H6do3p1ol, H8dotp [1,2]) was studied by means of molecular absorption spectroscopy in presence of Li+, Na+ and K+ salts employed as supporting electrolyte. It was found out that these ions significantly influence the rate of dissociation of Cu(II) complex in K+ < Na+ < Li+ order and the parameters of chemical model describing this reaction correlate with their ionic size [5,6]. This phenomenon can be explained by formation of weak complexes between the phosphonate group and the alkali metal ions, analogously as described for lanthanide(III) complexes of DOTP [6].

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References
Optimization of glyoxal, methylglyoxal and 3-deoxyglucosone determination by high performance liquid chromatography

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Dicarbonyl compounds, created by oxidation process, react with amino groups to form advanced glycation end products (AGE). Large amount of AGEs causes serious health complications in patients with diabetes such as vascular diseases, cataract, and Alzheimer’s disease. Glyoxal (GL), methylglyoxal (MG), and 3-deoxyglucosone (DG) are the main AGE precursors. The method of their determination can help identify the patients who are at increased risk of the diabetes complications. Simple methods are essential for routine use.

The aim of this study was to optimize the method of the AGE-precursors determination using high-performance liquid chromatography with fluorescence detection. Before measurement, the samples had to be derivatized by 1,2-diamino-4,5-dimethoxybenzene. The reaction was performed in dark, at low pH, and at room temperature. Then the derivatized sample was centrifuged and the supernatant was injected on the column with pre-column. For quantification, 6,7-dimethoxy-2,3-dimethylquinoxaline was used as the internal standard.

In the first step of the optimization, standard solutions of GL, MG, DG, and their mixtures were used. The HPLC method has been adjusted and the concentration range has been determined. The upper limit (GL 435 µmol/l; MG 10 µmol/l; DG 15 µmol/l) is set by the capacity of the derivatizing solution and sufficiently exceeds the concentrations that could possibly occur in the human body. The lower limit of the method (GL 0,05 µmol/l; MG <0,01 µmol/l; DG 0,03 µmol/l) is less than the physiological level. The results were compared with the calculated concentrations. According to the comparison, MG (CV 5%) and DG (CV 3%) results give very accurate information about the real concentrations. The signal of GL (CV 15%) is the lowest of the three compounds, but still sufficient. In the next step, the method was further adjusted to plasma samples. Particularly, additional washing of the column was necessary, as the plasma samples tended to increase the column pressure.

The HPLC method of AGE precursors determination has been optimized using standard solutions and plasma samples. The concentration range of the method has been determined.

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Predicting the FMOs of Pyronin: Towards Novel Pyronin-Based Dyes

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Fluorescent dyes based on pyronin and rhodamine scaffold are a subject of intense research due to their application potential in biology and medicine [1]. Enormous amount of synthetic work has been done to customize their absorption and emission properties in recent years. However, a rationale to predict these properties to avoid excessive laboratory experiments in preparation of a tailor-made fluorophore is largely missing. For example, the change in a heteroatom X in the position 10 (see Figure 1) caused the shifts in the experimental absorption and emission band maxima [2],[3], which, however, have never been explained. Here, we present a simple model based on analysis of the nodal properties of frontier molecular orbitals of pyronins that allows predicting their absorption properties. The model is validated by comparison of absorption spectra of pyronins which we synthesized and those obtained from the quantum-chemical calculations based on TD-DFT. This study allowed us to fine-tune the absorption of existing derivatives and to design novel pyronin fluorophores.

Figure 1. HOMO and LUMO of pyronin dyes

References
Optimization of selectivity and rate of complexation of copper radioisotopes

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Copper radioisotopes have a great potential for a wide use in nuclear medicine. Especially $^{61}$Cu ($\tau_{1/2} = 3.3$ h, $\beta^+$ emitter), $^{64}$Cu ($\tau_{1/2} = 12.7$ h, $\beta^+/$$\beta^−$ emitter) or $^{67}$Cu ($\tau_{1/2} = 61.8$ h, $\beta^−$ emitter) show suitable properties for both diagnosis and therapy. Isotopes are usually formed by irradiation of natural or enriched target materials. However after preparation, copper radioisotopes are obtained together with a large excess of competing metal ions (mother/daughter isotopes). Therefore a selective chelating metal ion resins might be used for copper radioisotope purification. Research presented here is focused on new ligands which can selectively complex only copper radioisotopes.

Cyclam (1,4,8,11-tetraazacyclotetradecane) is one of the best candidates for such studies as its derivatives form ones of the most stable known complexes of divalent copper. Optimization of the macrocyclic ligands’ design by suitable coordination pendant arm(s) can improve the desired properties [1,2].

New cyclam-based ligands with different coordinating pendant arms were synthesized and characterized. These derivatives were also investigated by $^1$H and $^{31}$P NMR titration (to compare of their protonation constants) and by kinetic investigations (formation and acid-assisted dissociation studies of the copper(II) complexes).

On basis of the studies, the most suitable derivatives were selected (with the most fast complexation and with suitable rate of acid-assisted dissociation of the copper(II) complexes) and these ligands were also radiochemically investigated with copper radioisotopes ($^{64}$Cu). The detailed information will be presented.

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References
Synthesis, characterization and properties of donor-acceptor macrocycles

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In recent years, π-conjugated macrocycles are a good candidate for the p-type semiconductors. In order to improve the efficiency of such materials, energy trade is a crucial matter for the designing of molecules. To decrease the energy gap between HOMO-LUMO, introduction of donor-acceptor motif is necessary, as a result, donor atom or functionality increases the HOMO energy level and acceptor decreases the LUMO energy level. Another important factor is planarity of molecules favoring strong π-π intermolecular interaction and thus improving the charge carrier transport in the solid state [1].

Here we present a synthesis of shape-persistent macrocycles that contain two different units in their vertices. One of them, the o-quinone or o-dinitrile, acts as an acceptor and creates a push-pull system with the others. Therefore, such materials have been of interest as long-wavelength absorbing dyes.

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References:
Copper complexes of 6-aminopurine and 6-benzylaminopurine in aqueous methanol solutions

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In order to follow many biological processes it is important to understand the interactions between nucleic acids and their constituents with metal ions [1]. It is known that adenine shows various probabilities of coordination with transition metal ions due to its potential donor sites. Electronically favoured coordination sites N(1) and N(3) for the metals were added by the nitrogens N(3) and N(9) due to tautomerization of the imidazole hydrogen atom between N(7) and N(9) [1,2]. In this contribution the protonation and stability constants of 6-aminopurine (adenine) or 6–benzylaminopurine (BAP) and their copper complexes were determined potentiometrically by using the titrator Titrando 835 controlled by tiamo 1.2 (Metrohm, Switzerland). The experiments were hampered by BAP solubility and all the potentiometric experiments were conducted in aqueous methanol solutions (10% (v/v) CH₃OH in water). The stability constants of the copper complexes were calculated for different ligand (purine):metal (copper) ratios according to the Sigel procedure [3,4]. Potentiometric titrations at different temperature and at the same ionic strength (0.1 M NaCl) enabled the thermodynamic evaluation of changes in enthalpy and entropy of the complexation process [5]. The temperature increase leads to a decrease in the values of the stability constants suggesting an exothermic behaviour for the complexation process. On the base of thermodynamic data (ΔH°, ΔS°) obtained for adenine and BAP the differences were attributed to the effect of the benzyl moiety.

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References
Preparations of High Surface Aluminophosphates from Trialkylphosphates and EtAlCl$_2$

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Since their introduction in 1982 [1], porous tailored aluminophosphates have found growing attention due to their applications as molecular sieves, catalyst carriers, and catalysts. Among various methods, non-hydrolytic syntheses using trialkylphosphates was showing promising results [2].

In our work, we focused on reactions of ethylaluminium dichloride with trimethyl- (TMP), triethyl- (TEP), triisopropyl- (TiPP), and tributyl phosphate (TBP). All reactions were carried out under inert atmosphere. We have tested various reaction conditions, investigated reaction mechanisms, and processed obtained xerogels into materials. Various processing conditions were investigated, as well as influence of templating.

![Figure 1. 2 μm SEM scan of calcined (left) and hydrothermally processed (right) TMP xerogel](image)

After calcination at 300 °C, we obtained amorphous aluminophosphates. Specimens obtained from TMP and TEP xerogels exhibited high surface area (up to 468 m$^2$ g$^{-1}$) provided by small mesopores. Higher calcination temperatures lead towards decrease of surface up to zero at 600 °C. Hydrothermal processing at 200 °C in an autoclave provided non-porous microcrystalline berlinite AlPO$_4$.

References


Synthesis and characterization of ZnO nanoparticles

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Zinc oxide is an important semiconductor with a direct wide band gap of 3.37 eV and a large exciton binding energy of 60 meV at room temperature. It has attracted considerable interest in the past years mainly because of its potential application in solar cells, chemical sensors and photocatalysts, etc. [1]. In the present work, ZnO nanoparticles have been synthesized by simple colloidal route and characterized by various techniques. The synthesis of ZnO nanocolloidal is based on a two-step procedure directed towards the initial thermal transformation of zinc acetate dehydrate ZnAc\textsubscript{2}·2H\textsubscript{2}O into highly reactive (Zn\textsubscript{4}O)Ac\textsubscript{6} clusters in ethanol medium followed by hydroxide induced condensation of ZnO nanoparticles [2]. The obtained ZnO nanoparticles were further coated with tetraethyl orthosilicate (TEOS). Then the nanoparticles were thoroughly characterized by different characterization methods such as UV-Vis spectrophotometry, dynamic light scattering (DLS) and small angle X-ray scattering (SAXS) that showed a ZnO nanocolloid in a size range 9-12nm. Basing on the SAXS data a pair-distance distribution function was used for \textit{ab initio} shape reconstruction of nanoparticles performed by dummy atom modelling as is implemented in \textit{DAMMIF} and \textit{DAMMIN}. The refined \textit{DAMMIN} model is shown in Figure 1.

Fig1. Pair-distance distribution functions and \textit{ab initio} models of ZnO (A) and ZnO/TEOS (B)

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References
Antioxidant properties and phytochemical composition of Mentha species and commercial peppermint teas

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The interest in clarifying the presence and function of biologically active compounds in plants is still growing and requires development of new analytical approaches. The knowledge about plant phytochemistry and their antioxidant properties helps to understand its medical effects and helps streamline its utilization in natural medicine. In this work, we focused on comparison between antioxidant properties and polyphenolic compounds determination in commercially available peppermint teas and Mentha species. Various extraction procedures were tested and the most suitable sample treatment with the highest efficiency was searched for [1]. High performance liquid chromatography (HPLC) with UV and MS detection was used as a tool for fingerprinting and antioxidant characteristics such as total polyphenolic content (TPC) and total antioxidant activity (TAA) were spectrophotometrically determined [2].

We compare information obtained from HPLC fingerprinting with the spectrophotometrically obtained data and discuss the similarities between commercially prepared herbal mixtures with known Mentha plant samples. In the tested peppermint herbal teas, a wide range of values for both antioxidant characteristics (TPC and TAA) was observed. Mostly, the values of TPC/TAA for peppermint teas corresponded to the price of tea however one of the highest values of TPC/TAA were determined in Lord Nelson mint tea (Lidl, Germany) which belongs to the one of the cheapest samples. The HPLC analyses provided information about representation of the typical Mentha plant polyphenols (caffeic acid, diosmin, eriocitrin, hesperetin, luteolin, luteolin-7-O-rutinoside, luteolin-7-O-glucuronide and rosmarinic acid) and along with spectrophotometric data served for the final evaluation [3].

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References
Specific spectroscopic, electrochemical and magnetic properties of Ln(III) ions make them perfect candidates for use in many chemical, biological and environmental systems. Ln(III) complexes with macrocyclic ligands (mainly DOTA derivatives) are commonly used in medicinal chemistry as contrast agents for MRI (Gd) and luminescent probes (Eu, Tb, Yb, Nd in VIS and NIR region). DO2A (1,4,7,10-tetraazacyclododecane-1,7-diacetic acid) and DO3A (1,4,7,10-tetraazacyclododecane-1,4,7-triacetic acid) are hexa- and heptadentate ligands forming very stable complexes with Ln(III) ions, where three, resp. two coordination places are occupied by water molecules. These complexes form ternary complexes with small mono- and bidentate ligands (e.g. fluoride, acetate, phosphate, oxalate, carbonate etc.) and therefore they can be proposed as sensitive sensors for the determination of these anions. Dual luminescent-electrochemical sensor based on [Ln(DO3A)(L)] and [Ln(DO2A)(L)] (Ln = Eu, Tb, L = picolinate, isoquinolinate) ternary complexes was developed for determination of bicarbonate in potential biological samples and complicated matrices [1].

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References
Porous Hybrid Inorganic-Organic Silicophosphate Materials by Non-Hydrolytic Sol-Gel Polycondensation and Their Use as Solid Phosphoric Acid Catalyst

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Non-hydrolytic sol-gel reactions are viable alternatives to classical aqueous techniques in the area of synthesis of multimetallic oxides and inorganic-organic hybrid materials in the form of xerogels, nanoparticles, and thin films. We developed a non-hydrolytic sol-gel route based on acetic acid ester elimination providing phosphosilicate hybrid inorganic-organic materials. The polycondensation reactions between Si(OAc)4 and OP(OSiMe3)3 lead to microporous phosphosilicate xerogels with surface areas up to 568 m² g⁻¹. The structure of xerogels was built up exclusively from Si–O–P bonds and contained octahedrally coordinated silicon atoms, which are characteristic for crystalline silicon phosphates [1]. We changed starting precursors to acetoxysilanes and phosphonic acid esters with bridging alkyl or aryl groups (AcO)3Si-(CH2)ₓ-Si(OAc)3 (x = 1-3, 6), (Me3SiO)2P(O)-3R-P(O)(OSiMe3)2 (3R = C2H4, C6H4). Silicon in acetoxysilanes with bridging organic groups was not able to acquire hexacoordination in contrast to Si in Si(OAc)4. The change of the structure of the xerogels, which were in this case built up from SiO4 tetrahedrons, was accompanied by the modification of textural properties – the hybrid phosphosilicates displayed significant mesoporosity [2]. The resulting samples were chemically modified with POCl3, water and methanol in order to introduce Bronsted acidic ≡P–OH groups onto the surface of xerogels. The products of chemical modification resembled solid phosphoric acid catalysts and were utilized in methylstyrene dimerization. The mesoporous silicophosphate samples with high number of ≡P–OH groups on the surface provided excellent yields and selectivities in this catalytic test reaction. The prepared xerogels were characterized by solid-state 13C, 29Si, 31P NMR, IR, surface area analysis, TGA, and XRD.

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References
Mesoporous zirconium silicate catalysts prepared by non-hydrolytic acetamide elimination

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All non-hydrolytic sol-gel reactions are efficient alternatives to classical aqueous techniques for the synthesis of multimetallic oxides and inorganic-organic hybrid materials. This process provides better reaction control and higher homogeneity of prepared materials. We developed non-hydrolytic sol-gel routes to several groups of metallosilicate materials and efficient catalysts based on acetamide elimination reactions [1, 2].

Our approach is based on the acetamide condensation reaction of silicon tetraacetate Si(OAc)\textsubscript{4} and zirconium diethylamide Zr(NEt\textsubscript{2})\textsubscript{4} that leads to the formation of Si–O–Zr bonds in the xerogel framework (evidenced by IR, $^{29}$Si CPMAS NMR). Diethylacetamide and acetanhydride were confirmed by GC-MS and $^1$H NMR as the reaction byproducts. To achieve the mesoporous nature of the xerogels, the reaction was successfully modified by the addition of the Pluronic P123 template with structure-directing and protecting functions which allow preparing stiff gels. After heat treatment the template is burned out and xerogels are mesoporous with high surface areas. The presence of four-coordinated Zr atom introduces catalytic activity to our products.

Calcined Si/Zr/O xerogels were tested in two types of catalytic reactions and the product yields were analyzed by GC-MS and $^1$H NMR. In the case of MPV reduction of 4-tert-butylcyclohexanone in 2-propanol the catalytic yield of 4-tert-butylcyclohexanone reached up to 55 % with a high selectivity for the \textit{trans} product. Our Si/Zr/O xerogels are also very effective catalysts for aminolysis of styrene oxide with the 94 % conversion to catalytic products. The resulting xerogels and volatile byproducts were characterized by liquid and solid-state NMR, IR, GC-MS, surface area analysis, TGA, XRD, and DRUV-Vis.

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Chemical synthesis of nanomaterials is a very progressive field of study. Preparation of nanoalloys is a challenging task due to their chemical, phase, and morphological variability. Nanoparticles of metal alloys exhibit many interesting properties, such as depression of melting point, plasmon resonance, magnetism, and catalytic activity. For nanoalloys preparation, the solvothermal synthesis, specifically in oleylamine is highly advantageous. Hot injection technique should ensure homogeneous conditions for nanoparticles nucleation and growth.

AgNi nanoparticles were prepared by injection of an oleylamine solution (4 cm$^3$) of AgNO$_3$ and Ni(acac)$_2$ (different ratios, 4 mmol total amount) to a mixture of oleylamine (16 cm$^3$) and octadecene (20 cm$^3$) at 230 °C. After 10 minutes, the reaction mixture was cooled down to room temperature in a water bath. Then 20 cm$^3$ of acetone was added and the mixture was centrifuged. Acetone was added to increase the yield. The precipitate was washed by a mixture of hexane and acetone (1:3 volume ratio). This procedure was repeated twice and finally the precipitate was dispersed in hexane and characterized.

Dynamic Light Scattering (DLS), Transmission Electron Microscopy (TEM), and Small-Angle X-ray Scattering (SAXS) analyses were carried out for determination of average size, size distribution, and shape of prepared nanoparticles. Obtained results were mutually compared. Thermal behavior was characterized by Differential Scanning Calorimetry (DSC). Plasmon resonances were observed and we found out that the intensity of plasmon resonance was dependent on the molar ratio of AgNi in the particles.

References
Synthesis and Supramolecular properties of water soluble Bambusuril derivative

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Supramolecular host that operates in “real life” environments are of great interest for biological and industrial chemist. Water is one of major environment in real life. Development of such a Supramolecular host that serves as anion receptors in pure water is a challenging task for chemists [1]. Previously only a few effective neutral anion receptors functioning in water are known. Herein we report an approach for the synthesis of a unique receptor bambusuril derivative 5 that shows strong associations toward several inorganic anions including iodide and perchlorate up to $10^7$ M$^{-1}$ in water [2]. NMR titration method was applied for the determination of association constants of all investigated anions; furthermore the associations of halides with bambusuril 5 were also examined by ITC. We also demonstrate that bambusuril 5 can be used for the qualitative and quantitative detection of anions at micromolar concentrations in pure water at pH 7.1 [3].

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