



Scientific Program

Abstracts Oral Presentations

Tuesday, February 14, 2017

Plenary Lecture
**Mechanistic Variants of Metal-Oxide Mediated C–H Bond Activation:
The Methane Challenge**

Helmut Schwarz

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Hydrogen-atom transfer (HAT) constitutes a key process in a broad range of chemical transformations as it covers heterogeneous, homogeneous, and enzymatic reactions. While open-shell metal oxo species [MO]· are no longer regarded as being involved in the heterogeneously catalyzed oxidative coupling of methane ($2\text{CH}_4 + \rightarrow \text{C}_2\text{H}_6 + \text{H}_2\text{O}$), these reagents are rather versatile in bringing about (gas-phase) hydrogen-atom transfer, even from methane at ambient conditions. In this lecture, various mechanistic scenarios will be presented, and it will be demonstrated how these are affected by the composition of the metal-oxide cluster ions. Examples will be discussed, how ‘doping’ the clusters permits the control of the charge and spin situation at the active site and, thus, the course of the reaction. Also, the interplay between supposedly inert support material and the active site – the so-called ‘aristocratic atoms’ – of the gas-phase catalyst will be addressed. Finally, gas-phase HAT from methane will be analyzed in the broader context of thermal activation of inert C–H bonds by metal-oxo species and it will be shown that the investigation of ‘doped’ metal oxide clusters as mimics for catalytic processes is about to enter into widely uncharted territory of chemistry, a field in which “each atom counts”.

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Keynote Lecture

The Stability of Nitrogen-Centered Radicals

Hendrik Zipse

Department of Chemistry, Ludwig-Maximilians University of Munich (LMU), Muenchen, Germany

The stability of nitrogen-centered radicals can conveniently be defined relative to the aminyl radical ($\bullet\text{NH}_2$) as the unsubstituted (and thus unstabilized) parent system. These "radical stabilization energies" (RSEs) are identical to differences between N-H bond dissociation energies (BDEs) in ammonia (NH_3) and the parent amines. Based on the same logic the stability of carbon and oxygen-centered radicals can be quantified and presented graphically as shown in Fig. 1. Using the reference systems H_2O , NH_3 , and CH_4 the RSE data for oxygen-, nitrogen-, and carbon-centered radicals can be combined in a global scale of BDE values (Figure 1). Using this type of presentation the reaction enthalpy of hydrogen transfer steps between amines and C- or O-centered radicals can be predicted in a straightforward manner. Using recently calculated data for a variety of nitrogen-centered radicals, substituent and environmental effects on N-radical stability will be discussed.

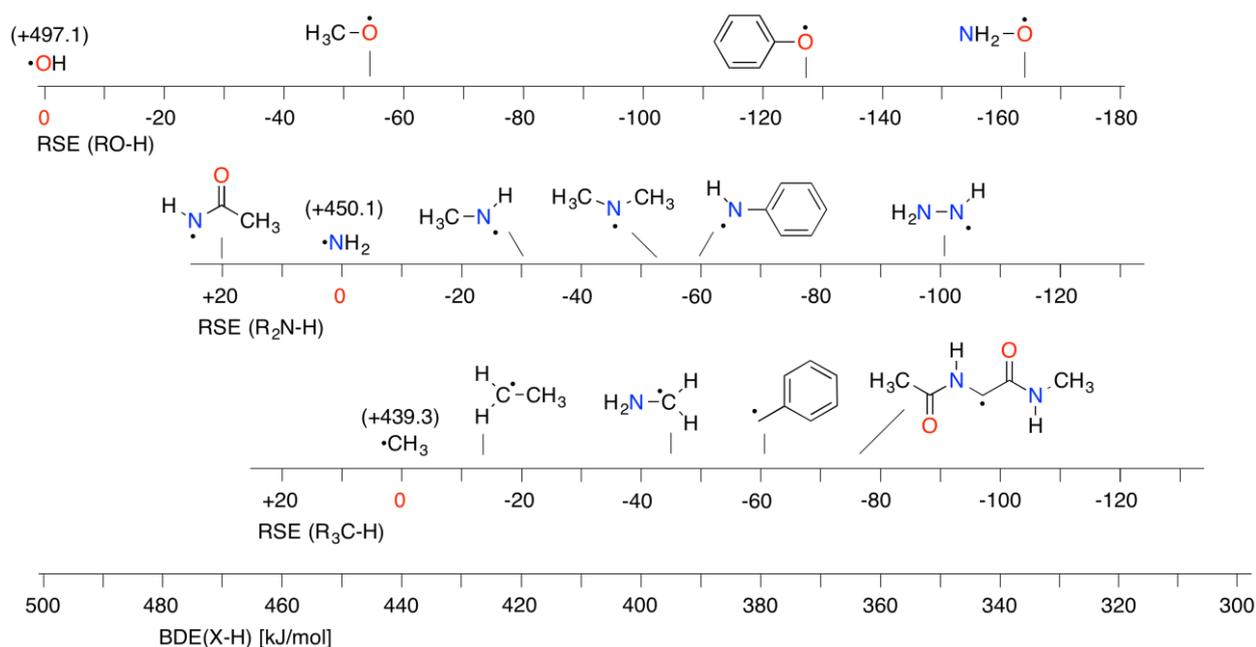


Figure 1. Radical stabilization energies (RSEs) for selected open shell systems (in kJ/mol).

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ICS Young Scientist Prize

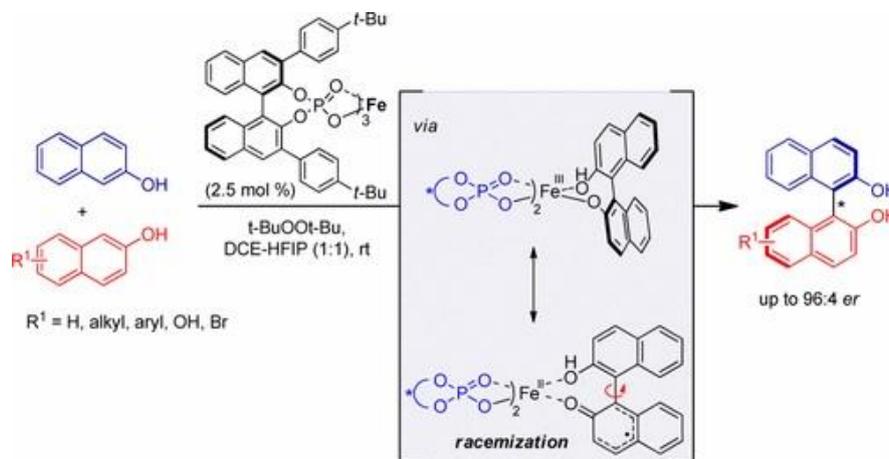
Chiral Iron Phosphate Complexes for Asymmetric Cross-Dehydrogenative Coupling Reactions

Doron Pappo

Department of Chemistry, Ben-Gurion University of the Negev, Beer-Sheva, Israel

Iron-catalyzed oxidative cross-coupling reactions provide an environmentally friendly strategy to form new C-C bonds directly from two C-H bonds. The biomimetic oxidative cross-coupling of phenolic components suffers from a lack of selectivity, making the cross-coupling of two non-identical reactants at specific sites difficult to obtain. To address the selectivity issue in these reactions, my group developed a set of highly selective oxidative cross-coupling reactions catalyzed by different iron catalysts that follow distinct coupling mechanisms. We applied kinetic studies, electrochemical methods and DFT calculations to elucidate some of the factors that control the chemoselectivity and regioselectivity in phenol-phenol and phenol-arene cross-coupling reactions. We then developed a prediction model to anticipate the feasibility of pairs of phenols to favor cross-coupling over homocoupling, thereby enabling efficient synthesis of specific phenolic architectures with high degrees of chemoselectivity and regioselectivity.

The presentation will focus mainly on our efforts to address the asymmetry challenge in cross-dehydrogenative coupling (CDC) reactions. For that purpose, novel chiral iron phosphate complexes were prepared as catalysts for the synthesis of enantio-enriched C₁- and C₂-symmetric 1,1'-bi-2-naphthols (BINOLs) and for the stereoselective CDC between 2-naphthols and α -substituted- β -ketoesters. A destructive BINOL racemization process that competes with the enantioselective oxidative coupling of 2-naphthols was revealed, thereby offering new insights into this highly important reaction.



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ICS Young Scientist Prize

Molecules that Generate ‘Fingerprints’: A New Class of Fluorescent Probes for Chemical Biology and Cryptography

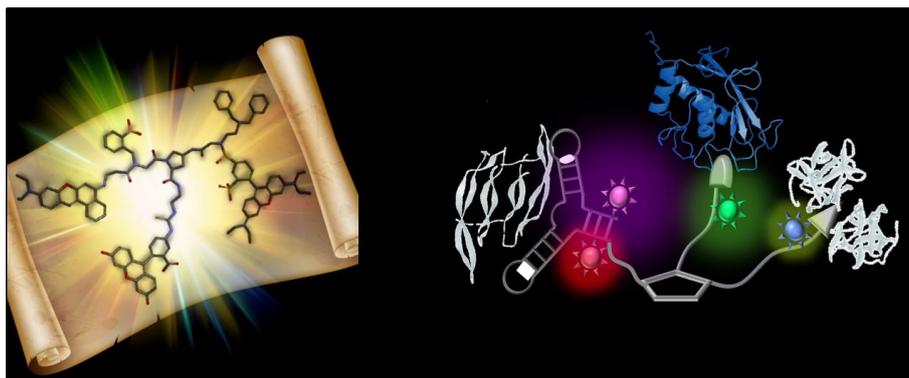
David Margulies

Organic Chemistry, Weizmann Institute of Science, Rehovot, Israel

Our group has recently developed a new class of molecular sensors, termed ‘combinatorial fluorescent molecular sensors’, which mimic the function of cross-reactive sensor arrays (the so-called chemical “noses/tongues”).¹⁻³ In this talk I will explain how these pattern-generating probes can be used to analyze specific populations of proteins in complex mixtures and within live cells. In addition, I will show how secret messages can be concealed within the emission spectra of these unimolecular analytical devices.⁴

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- [1] B. Rout, L. Unger, G. Armony, M. A. Iron and D. Margulies, *Angew. Chem. Int. Ed.* **2012**, 21, 12477-12481.
- [2] B. Rout, P. Milko, M. A. Iron, L. Motiei and D. Margulies, *J. Am. Chem. Soc.* **2013**, 135, 15330-15333.
- [3] B. Rout, L. Motiei and D. Margulies, *Synlett* **2014**, 25, 1050-1054.
- [4] T. Sarker, K. Selvakumar, L. Motiei, D. Margulies, *Nat. Commun.* **2016**, 7, 11374-11382.



Catalytic, Metal-Free Functionalization of Si-H Bonds

Roman Dobrovetsky

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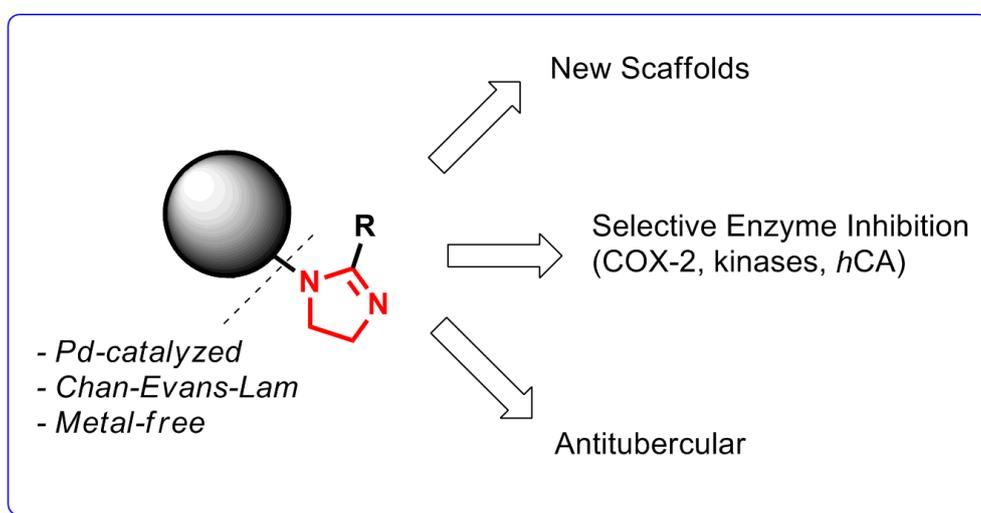
Si-H bond activation is usually considered a domain of transition-metal complexes, and only few metal-free systems have proven suitable for this task. In this talk, I will present new metal-free methods for the activation of Si-H bonds that were recently developed in our group. We have now found new Lewis acid catalyzed methodology for selective chlorination of $R_{3-n}SiH_n$ ($n = 1-3$, $R = \text{Alk, Ar}$) into corresponding chlorosilanes using HCl and $(C_6F_5)_3B \cdot OEt_2$ as catalyst. In addition, we found that ethers (R_2O) can be cleaved catalytically in presence of silanes and catalytic amount of $(C_6F_5)_3B \cdot OEt_2$ leading to alkoxy-silanes ($R'O-SiR_3$) and the corresponding alkanes (R'). The mechanisms for these reactions were studied both experimentally and theoretically and will be presented as well.

N-Aryl Imidazolines in Scaffold- and Lead-Oriented Synthesis

Mikhail Krasavin

Institute of Chemistry, Saint-Petersburg State University, Saint Petersburg, Russia

Our group has been active in the chemistry of 2-imidazolines where we particularly emphasized N-arylation approaches. In 2012, we reported a pioneering method on Pd-catalyzed N-arylation of this special case of cyclic amidines and applied this approach toward the construction of COX-2, carbonic anhydrase and selective kinase inhibitory as well as antitubercular compounds. In 2016, we developed a room-temperature Chan-Evans-Lam procedure to introduce electron-neutral and electron-rich aromatic groups at the nitrogen atom of 2-imidazolines. This has now been applied to expand the SAR knowledge base around COX-2 and carbonic anhydrase inhibitors. Particularly intriguing is the prospect of achieve, in an intramolecular fashion, imidazoline N-arylation with no metal involved. We have identified such an opportunity and recently applied it toward a novel approach toward medium-sized rings. The latter are of high interest as potential disruptors of therapeutically important protein-protein interactions.



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1. Krasavin, M. Novel diversely substituted 1-heteroaryl-2-imidazolines for fragment-based drug discovery. *Tetrahedron Lett.* 2012, 53, 2876-2880.
2. Mujumdar, P.; Grkovic, T.; Krasavin, M. A simple two-step access to diversely substituted imidazo[4,5-b]pyridines and benzimidazoles from readily available 2-imidazolines. *Tetrahedron Lett.* 2013, 54, 3336-3340.
3. Sarnpitak, P.; Mujumdar, P.; Morisseau, C.; Hwang, S. H.; Hammock, B.; Iurchenko, V.; Zozulya, S.; Gavalas, A.; Geronikaki, A.; Ivanenkov, Y.; Krasavin, M. Potent, orally available, selective COX-2 inhibitors based on 2-imidazoline core. *Eur. J. Med. Chem.* 2014, 84, 160-172.
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Keynote Lecture
**Moving the Goalposts – Case Studies in Academic Drug Discovery from the
G-INCPM**

Haim Barr

*The Nancy and Stephen Grand Israel National Center for Personalized Medicine,
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The non-biased process of identifying chemical compounds with pharmaceutical application has traditionally been associated with industry, rather than basic academic research. However due to the high infrastructure costs and a difficulty to predict a successful outcome at the initial early discovery stage, the trend has been for progressively limiting pharmaceutical industry activities in this area. Nevertheless, many drugs originate from this process and high throughput screening has now become commonplace in small and medium biotechnology enterprises as well as in academic facilities attempting to bridge between basic research and industrial development.

The Nancy and Stephen Grand Israel National Center for Personalized Medicine (G-INCPM) was established as a facility to advance academic, clinical, and industrial research with an emphasis on genetic and proteomic data generation and analysis. The G-INCPM stresses collaborations through high-end technology centers in fields where access to these technologies may be limiting the impact of basic research. Within G-INCPM, The Maurice and Vivienne Wohl Institute for Drug Discovery provides a flexible platform for bioassay development and small molecule discovery for targeted and phenotypic compound screening. A clear need has emerged from the academic community for chemical biology tools to advance basic research questions and for better small organic probe compounds which could be leveraged for drug development. In the talk I will discuss the challenges we have encountered in many of our collaborations and specifically during the discovery novel inhibitors of the lipid phosphatase Synaptojanin 2, and the Nicotinamide N-Methyl Transferase. Finally, I will introduce the OpenScreen, which is a new multi-national EU-based consortium that collects diverse chemical libraries from academic laboratories across Europe into a single resource and is deployed to national screening centers in member states.

Bromine-Based Flow Batteries for Long Duration Storage – Chemicals and Developments

Ronny Costi¹, Ran Elazari¹, Peter Steunenber², Iris Ben-David¹, Olga Golberg-Oster¹,
Sharona Atlas³

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³*Business Development, ICL, Beer-Sheva, Israel*

Flow Batteries present an optimal energy storage vessel for large applications and long durations, due to the decoupling of energy and power in the battery. The energy is dependent on the amount of electrolyte and the power on the electrodes and cell design.

Elemental bromine as a strong oxidizer with reversible electrochemical activity is well suited for use in flow batteries. There are several bromine based technologies where the most dominant are the zinc bromine and hydrogen bromine technologies. Among the advantages of the bromine based batteries are the fire proof nature and high energy density.

The use of bromine in batteries raises several challenges in cell design, safety and operations. As an example, bromine is corrosive with high vapor pressure; this creates a safety concern and requires the use of specific anti-corrosive construction materials. Also, bromine is a liquid with a fairly low boiling temperature which limits the cell operating temperatures. These challenges can be dealt with using a bromine complexing agent (BCA) within the cell. Bromine complexing agent is a material that forms a meta-stable moiety, or complex, with the elemental bromine molecules. The complex is at a constant equilibrium between free and bound bromine which allows for a lower free bromine concentration to be available while maintaining a constant supply of bromine in the cell for operation. Lower concentration of free bromine lowers corrosiveness and vapor pressure allowing cheaper construction materials and simpler design of the battery. BCAs also enable work at higher temperatures, improving electrochemical efficiencies and negating expensive chillers.

We shall present a case study of tailoring BCA properties according to customer requests.

"From Discovery to Drug" - Selected Topics on Drug Development and its Pitfalls

Gideon Silberman, **Sylvia G. Kachalsky**

Business Development, Recipharm Israel, Ness Ziona, Israel

The process of drug development from inception of the idea to drug approval encompass a series of specialized activities involving many different professionals. Drug development is typically divided into three major steps: discovery, preclinical development, and clinical trials. While the transition from discovery to preclinical development is a continuum the limit between preclinical development and clinical trial is sharply defined by the IND filing.

Although covering the same process, drug development in small companies or start ups has its specific constraints and pitfalls. The adage "Begin with the end in mind" cannot be more certain than in pre-clinical development and specially in small companies where choosing resource allocation can determine success or failure. It is essential thus, to plan carefully all the different steps to reach the goal – FDA approval and commercialization of a new drug.

Development of in house capabilities or Contract organizations, number of synthesis steps versus lead optimization to reduce them, when to enter GLP and GMP, pre-formulation, early DMPK or whether to use and in what extent predictive software are some of the critical steps that many companies face. We would like to provide some information, based in our experience, about these steps and their importance in the drug development process.

Implementation of Impurity Strategy in API Process Development

Nurit Perlman

TAPI R&D, Teva Pharmaceutical Industries, Petah Tikva, Israel

Development of process for Active Pharmaceutical Ingredient [API] is characterized by variety of aspects that should be considered while choosing the route of synthesis (RoS). Among these aspects are process safety, cost efficiency, ecological considerations, process robustness, and patent restrictions. However, once the RoS is being chosen many efforts are made to achieve the best and the uncompromising quality of API according to the requirements imposed by health authorities.

In our attempt to provide the highest quality API to our patients, we conduct a deep study to understand, identify and control the potential process related impurities formed in the course of synthesis. The implementation of impurity strategy will be illustrated by case studies from the R&D of TEVA's API division.

Modeling of the Tertiary Current Distribution Inside the Chlor-Alkali Electrolysis Cell

Yuri Khodorkovsky, David Furman

Chemistry Division, Nuclear Research Center Negev, Beer-Sheva, Israel

During the past decade the study of industrial electrochemical systems, such as electrolysis cells, fuel cells and batteries using numerical simulations, became widespread. This progress is possible partially due to the development of user friendly simulation tools, such as COMSOL Multiphysics[®], based on the solution of differential equations using the finite element method (FEM). Moreover, capabilities specifically dedicated to electrochemical systems, such as the primary/secondary/tertiary current distribution modules, were recently introduced. They enable fast and efficient way of building models with complex geometries and different boundary and initial conditions.

Specifically, the modeling of industrial chlor-alkali membrane cells for chlorine and sodium hydroxide production from brine solution is important for the design of new cells, as well as for the understanding and the improvement of existing cells [1]. Following P. Byrne et al. [2], we studied the distribution of the potential, the current density and the concentrations of different species inside a `lantern` cell of the ICI FM-21 electrolyser.

The pseudo-tertiary current distribution was calculated without the rough approximation used in [2], which neglected the migration motion of the ions in the diffusion boundary layer. In addition, a time-dependent full tertiary current distribution was found, and the growing diffusion boundary layer near the electrodes was visualized. This time-dependent study may be useful in describing the turn-on process of the electrolysis cell, when convective currents may be neglected.

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[2] P. Byrne, P. Bosander, O. Parhammar and E. Fontes, J. Appl. Electrochem. **30**, 1361 (2000).

Novel Efficient and General Bromo-Decarboxylation Method

Alexander Artaryan, Kseniya Kulbitski, Idan Avigdori, Gennady A. Nisnevich,
Mark Gandelman

Schulich Faculty of Chemistry, Technion - Israel Institute of Technology, Haifa, Israel

The invention idea is based on the conversion of cheap and widely-available carboxylic acids (feedstock chemicals) to valuable organic bromides[1], which are an integral part of Israel's chemical industry.[2] The production of organic bromides proceeds typically from costly alcohols or related precursors, both domestically in Israel or abroad.[3] Thus, economical and environmentally benign approach to organo-bromine compounds will have positive industry-wide ramifications.

Bromodecarboxylation is a selective and attractive method for the synthesis of organic bromides. The synthesis of alkyl bromides from carboxylic acids has been known since 1939, with many different methods developed.[4] Although extensively deployed in research laboratories, they have found little foothold in industry. The reason is that all the existing methods are complicated, require expensive, oxygen and moisture sensitive[5], toxic[6] and highly-regulated chemicals (for instance by the FDA).

Here we present a new, extremely simple, efficient and metal-free bromodecarboxylation method. Our one-step protocol employs robust brominating agents, ambient conditions, and doesn't require laborious product purification. The reaction is general: primary, secondary, tertiary alkyl bromides as well as aryl bromides can be prepared in high yields.

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Keynote Lecture

Light-Induced Processes in Covalent Organic Frameworks

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Ludwig-Maximilians University of Munich (LMU), Munich, Germany

We explore the opportunities offered by spatially integrating photoactive molecular building blocks into a crystalline lattice based on the paradigm of covalent organic frameworks (COFs), thus creating models for organic bulk heterojunctions. In this presentation, we will address means of controlling the morphology and packing order of COFs through additives,(1) in thin films,(2) and with spatially locked-in building blocks.(3) Regarding the latter, the design of well-defined periodic docking sites enables us to achieve remarkably high crystallinity with several multidentate building blocks and a series of linear bridging units (see Figure 1).

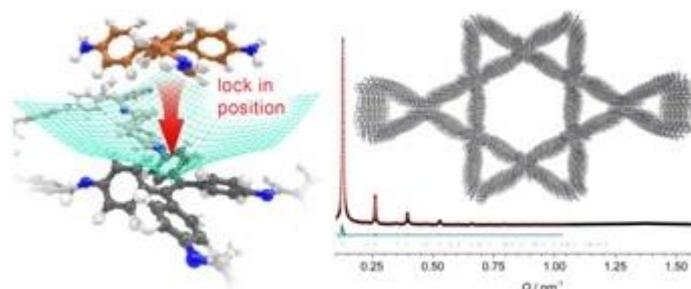


Figure 1. Docking site in COF network, representative diffractogram and stacked lattice of a docked dual-pore COF (3).

We will discuss different strategies aimed at creating electroactive networks capable of light-induced charge transfer. For example, we have developed a COF containing stacked thienothiophene-based building blocks acting as electron donors with a 3 nm open pore system, which showed light-induced charge transfer to an intercalated fullerene acceptor phase.(4) Contrasting this approach, we have designed a COF integrated heterojunction consisting of alternating columns of stacked donor and acceptor molecules, promoting the photo-induced generation of mobile charge carriers inside the COF network.(5) The great structural diversity and morphological precision that can be achieved with COFs make these materials excellent model systems for organic optoelectronic systems.

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Hydrogen Sensors Based on 2D Arrays of Self-Assembled Core-Shell Nanoparticles

Linda Baklouti, Khalil Rajoua, **Frederic Favier**

Institut Charles Gerhardt Montpellier - ICGM, CNRS - University of Montpellier, Montpellier, France

Au@Pd and Au@Pt core-shell nanoparticles are synthesized with a good control in the precious metal shell thickness. Resulting colloids are assembled as hexagonal close-packed 2D monolayers by using a simple Langmuir-Blodgett method and transferred by dip-coating at the surface of a glass slide supporting interdigitated electrodes. The fabricated resistive sensors show attractive hydrogen sensing performances with reversible responses in extended sensing ranges, a good specificity towards H₂, short response and recovery times.

For Au@Pt based sensors, the dissociative chemisorption of H₂ and O₂ on Pt surface leads to the formation of chemisorbed hydrogen and hydroxyl groups. This surface nature change induces the modification of the scattering of the conduction electrons at both grain surface and intercontacts, tuned by the extent of hydrogen and hydroxyl group coverages. Depending on the Pt shell thickness, scattering at the surface or grain boundaries accounts for the observed conductive or resistive responses, respectively, while the overall sensing behavior is balanced by these two antagonist effects. For Au@Pd based sensors, the specific reactivity of palladium towards hydrogen, leading to the reversible conversion of Pd as PdH_x, is originating for the H₂ concentration dependence of the observed either resistive or conductive responses. In terms of amplitude and sign, these responses strongly depend on the balanced contribution of two antagonist mechanical and electronic effects, promoted by the palladium hydride formation under H₂ atmosphere.

By using the percolation theory and simple data modeling, these Pt and Pd thickness dependent contributions are decorrelated and the sensing mechanisms are described.

From Pathological Amyloids to Functional Biomaterials

Ulyana Shimanovich

Materials and Interfaces, Weizmann Institute of Science, Rehovot, Israel

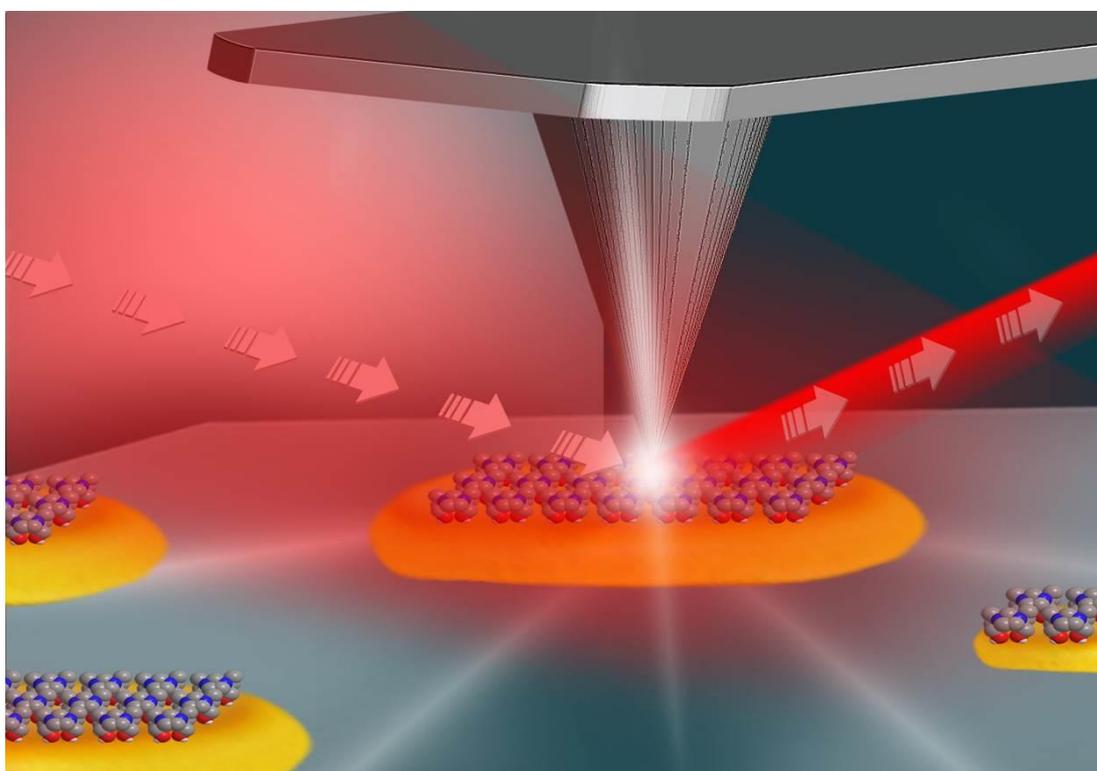
Our lab research focus on self-assembly processes in biopolymers to understand structure-function relationships, with emphasis on studies related to biomaterials made of natural proteins and peptides and design of bio-inspired nanomaterials. The studies include a variety of fibrous proteins, including functional as well as pathogenic amyloids, food proteins and silks. The lab has pioneered the study on controlling self-assembly processes in highly aggregation-prone material such as Native silk and its impact on stabilization/inhibition of aggregation in pathogenic amyloids. These systems are used to study diseases associated with neurodegenerative disorder, including for screening of therapeutic compounds. Our goal is to unravel the evolution, biology, physics and chemistry of the biomaterials made of self-assembled natural building blocks.

High Spatial Resolution Mapping of Catalytic Reactions on Single Particles

Elad Gross

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The critical role of low-coordinated metal atoms in surface reactions and heterogeneous catalysis has been firmly established. But despite the growing availability of tools enabling detailed *in situ* characterization, it has so far not been possible to directly document this role: surface properties can be mapped with high spatial resolution and catalytic conversion can be documented with a clear chemical signature, but combination of the two, enabling high spatial resolution detection of reaction on catalytic surfaces, was rarely achieved. Here we show that differently active regions within a given particle can be distinguished by mapping the chemical reactivity of N-Heterocyclic Carbene molecules (NHCs) attached to catalytic particles using synchrotron radiation-based infrared nanospectroscopy (SINS) with a spatial resolution of 25 nm. It is demonstrated that compared to flat regions on top of the particles, the particles' periphery, containing low-coordinated metal atoms, is more active in catalyzing oxidation, as well as reduction, of chemically active groups in surface-anchored NHCs. These results indicate that high spatial resolution vibrational spectroscopy measurements can correlate between surface properties and reactivity of single catalytic nanoparticles.



Doping of MoS₂ and WS₂ Nanostructures

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²*Materials and Interfaces, Weizmann Institute of Science, Rehovot, Israel*

Layered compounds like WS₂ or MoS₂, have strong (covalent) bonds in the layer (a-b plane) and weak van der Waals forces along the c-axis. The high energy stored in the dangling bonds at the periphery of these nanoscopic sheets may induce formation of inorganic nanotubes and fullerene-like nanoparticles (INT and IF) [1]. Due to their unique properties and applications, the study of these nanostructures is a rapidly growing field. Here, the existing synthetic methods for production of INT-WS₂ method was substantially modified and improved. Interestingly, it was found that by slight changes of the conditions, such as temperature, pressure or gas flows rate, we get a variety of different nanostructures (i.e. WO_{2.78} nanowires, WO_{2.78}@WS₂ core shell nanowires, WS₂ scrolls, IF nanoparticles, thin sheets, spear-like nanotubes and more). Since the IF/INT are semiconductors, their properties can be controlled by doping. Indeed, it was shown that doping of the IF/INT with a few hundred ppm of Re atoms leads to their increased conductivity and to substantial decrease in friction and wear [2]. Study of the optical properties of the Re doped IF-MoS₂ revealed that these NPs undergo Burstein-Moss optical shift due to band filling [3]. Inspired by the fascinating properties of the doped IF/INT, the optical and electronic properties of the undoped counterparts were reconsidered. Herein, it was found that the IF-MoS₂ and INT-WS₂ maintains not only the excitonic structure of the bulk, but also the plasmonic scattering (which does not exist in the bulk) [4]. The strong light-matter interaction in the IF/INT-MS₂ suggests that they can operate as a plasmonic device at room temperature.

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3. Sun, Q.C., Yadgarov, L., et al., ACS nano, 2013.
4. Yadgarov, L., et al., ACS nano, 2014.

Keynote Lecture
**Deciphering the Extraordinary Energy Transfer Capabilities of the
Phycobilisome Photosynthetic Light Harvesting Complex**

Noam Adir

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The initial steps in biological photosynthetic solar energy conversion are performed by light harvesting complexes (LHC) that efficiently absorb light and perform energy transfer to the reaction centers. The phycobilisome (PBS) is the main LHC in cyanobacteria and red algae. PBS function is far more robust than typically assumed, performing energy transfer over large distances in a wide range of configurations and surroundings. We have determined high resolution structures of PBS components from a wide variety of cyanobacterial species and developed stabilization methods for analysis of higher level assemblies. This allows the analyses of isolated components and the entire PBS using: crystallography and cryo-TEM [1] solution [2] and surface spectroscopies [3] and coupled cross-linking/MS [4, 5]. The functional robustness of the PBS components suggests that they could be used in non-biological devices involving long range excitonic coupling. Using these methods, we are able to model the PBS and propose energy transfer pathways. In addition, we have recently analyzed the interaction between the Orange Carotenoid Protein (OCP) and the PBS and based on the identified constraints we have suggested a possible mechanism by which the OCP drastically decreases the flow of energy from the PBS to the reaction centers [5].

Acknowledgements: this work is supported by the US-Israel Bi-National Science Foundation (2014395) and the Israel Science Foundation (1576/12)

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Detection of Intermolecular NOEs in Small and Large Protein/Peptide Complexes

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Weak protein-ligand interactions play important roles in biological recognition. Detection of pairwise interactions in such complexes is a major challenge for both X-ray crystallography and NMR. We developed two approaches that rely on transferred nuclear Overhauser effect, TRNOE, to detect such interactions.

TRNOE, in combination with asymmetric deuteration of a protein and a peptide ligand was used to detect intermolecular interactions in HIV-1 gp120 ternary complex with a CD4-mimic miniprotein and a 27-residue peptide corresponding to the N-terminal segment of the CCR5 chemokine receptor, Nt-CCR5(1-27). The TRNOE cross peaks in the ternary complex were assigned to the specific Tyr protons in Nt-CCR5(1-27). The TRNOE/asymmetric deuteration method benefits from the sensitivity of the NOESY experiment and does not suffer from the sensitivity losses associated with isotope edited/isotope filtering approaches that rely on magnetization transfer between protons and heteronuclei bonded to them. This technique can be widely applied for studying large protein complexes that exhibit fast off-rates.

In a following study, we demonstrated that TRNOE in combination with the ¹³C-edited/¹³C-filtered NOESY experiment can be used to study intermolecular interactions also in small and medium sized protein complexes. We used this approach to study the interactions of the chemokine RANTES with the Nt-CCR5(1-27) peptide. The TRNOE phenomenon led to more than doubling in the signal to noise ratios (SNR) for the intermolecular NOEs observed in the ¹³C-edited/¹³C-filtered experiment for the 11.5 kDa complex of monomeric RANTES with Nt-CCR5(1-27). An even better improvement in the SNR was achieved with dimeric RANTES complex with Nt-CCR5(1-27) (23 kDa). The isotope-edited/isotope filtered TRNOE spectrum has the potential to show all intermolecular interactions in the complex.

Probing Lead Halide Perovskites with High Resolution Ultrafast Spectroscopy

Sanford Ruhman, Vinay Sharma, Sigalit Aharon, Tufan Ghosh, Chunfan Yang, Lioz Etgar
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High time resolution broadband pump-probe experiments on $\text{CH}_3\text{NH}_3\text{PbI}_3$ and $\text{CH}_3\text{NH}_3\text{PbBr}_3$ films which delineate instantaneous and delayed relaxation effects on sample absorption are described. Analysis of the data reveals that photoexcitation high in the inter-band continuum partially bleaches and red shifts the exciton band instantaneously. Increased pump intensity saturates the exciton bleach and progressively reduces inter-band absorption in a broad range extending from the band edge to higher photon energies. Both effects are attributed to reduced Coulomb enhancement due to hot carrier screening. The spectral extent of the inter-band absorption attenuation provides estimated binding energies of 20-30 meV in both materials. Sub-picosecond carrier cooling reverses the initial exciton transition red shift and induces transmission near the band edge due to state filling and stimulated emission. These results demonstrate that both inter-band and exciton absorptions are essential for unraveling photo-induced dynamics in these materials, and that insights obtained from many-body theoretical analysis of dynamic screening are essential for correctly assigning the recorded spectral evolution. Finally very recent experiments with sub 10 fsec pulses will be presented which are sensitive to the ultrafast breakup of hot excitons, high above the band gap.

Development of Correlative Stochastic Optical Reconstruction Microscopy and Cryo-soft X-ray Tomography of Cholesterol Crystal Early Formation in Cells

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One of the most versatile imaging techniques in biology, fluorescence microscopy, allows noninvasive imaging with molecular specificity. However, the resolution of a conventional wide-field fluorescence microscope is limited by the diffraction of light (~200-300 nm). Recent advances in far-field optical nanoscopy provide spatial resolution of 20-50 nanometers that is well below the diffraction limit. Combining super resolution fluorescence microscopy with additional high resolution imaging technique is highly attractive. Correlation of two imaging approaches allows specific cellular characterization together with a highly complete view of the cell ultrastructure. We therefore were inspired to develop a high resolution correlative method involving cryo-soft X-ray tomography (cryo-SXT) and stochastic optical reconstruction microscopy (STORM), which provides information in three dimensions on large cellular volumes at 70 nm resolution. Cryo-SXT morphologically identifies and localizes aggregations of carbon-rich materials. STORM identifies specific markers on the desired epitopes, enabling colocalization between the identified objects, in this case cholesterol crystals, and the cellular environment. The samples were studied under ambient and cryogenic conditions without dehydration or heavy metal staining. The early events of cholesterol crystal development were investigated in relation to atherosclerosis, using as model macrophage cell cultures enriched with LDL particles. Atherosclerotic plaques build up in arteries in a slow process involving cholesterol crystal accumulation. Cholesterol crystal deposition is a crucial stage in the pathological cascade. Our results show that cholesterol crystals can be identified and imaged at a very early stage on the cell plasma membrane and in intracellular locations. This technique can in principle be applied to other biological samples where specific molecular identification is required in conjunction with high resolution 3D-imaging.

Structural Effects of Single Mutations in a Filamentous Viral Capsid Across Multiple Length Scales

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²*School of Physics and Astronomy, Tel Aviv University, Tel Aviv, Israel*

Viral mutations are a main source of resistance to medical treatment. By combining SAXS and magic-angle spinning (MAS) NMR we relate single-site mutations in the filamentous bacteriophage virus fd to structural changes over several length scales. The atomic-scale was examined by solving the quaternary structure of the phage[1], and by comparing NMR chemical shifts of three forms: wild-type, D12N, and Y21M. Inter-particle interactions experienced by different mutants on the nano-scale were studied by the SAXS osmotic pressure technique and the micron-scale, i.e. liquid crystal formation and phage alignment, was examined from SAXS and from optical birefringence.

We show that a single-site charge mutation (D12N – M13 virus) on the surface of the capsid, has a negligible effect on its structure however, a mutation in the hydrophobic packing region (Y21M) has a significant impact: it changes the symmetry, the subunit structure and the packing of the phage, and on the micron-scale it significantly alter the pitch of cholesteric liquid-crystals formed by the virus. Despite the fact that changes occurring in the atomic-scale propagate to the macroscopic scale, those changes skip the nano-scale; SAXS measurements we employed on the three forms of the virus (wt-fd, D12N, fd-Y21M) at different salt and osmotic pressure conditions suggest that inter-particle interactions are not significantly affected by the hydrophobic Y21M mutation. On the other hand, these interactions are significantly affected by the D12N charge mutation. Modelling of the SAXS data also allowed us to re-estimate the effective particle charge and show that the non-stoichiometric nucleotide-to-subunit ratio is the source of the net charge on the virus.

Since such mutation affect differently the organization of phage particles, our studies can direct smart design of phage-inspired bio- and nano-technology.

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The Endocannabinoid System – a Look Back and Ahead

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Over the last few decades research on the cannabinoids has gone through several distinct phases:

A. Research on the plant cannabinoids [mostly on tetrahydrocannabinol (THC) and cannabidiol (CBD)]

Thousands of publications have been published on the plant cannabinoids and some of them are already in use as therapeutic drugs. Of particular interest is CBD, which does not cause the typical cannabis psychoactivity, but is an anti-epileptic drug and is being evaluated in other therapeutic areas (schizophrenia and auto-immune diseases for example).

B. Research on the endogenous cannabinoids [mostly on anandamide and 2-arachidonoyl glycerol (2-AG)]

Anandamide and 2-arachidonoyl glycerol (2-AG) are involved in a very large number of human diseases, mostly as neuroprotective entities.

C. Research on endogenous fatty acid amides with amino acids and ethanol amines.

Endogenous fatty acid amides with amino acids and ethanol amines (anandamide-like compounds) have been shown to be of major importance in a large spectrum of biological functions and diseases. Thus, oleoyl serine is an anti-osteoporotic molecule and arachidonoyl serine is a vasodilator and lowers brain damage.

Numerous pharmaceutical companies are now involved in research in all the above areas.

Chemistry of Herbicides – Winning the Competition

Alexander Shterenberg

Chemical R&D, Adama-Agan, ADAMA Agricultural Solutions Ltd., Ashdod, Israel

Living organisms continuously compete for available resources – this is a major driving force of Evolution. Plants compete against each other (both interspecific and intraspecific) on available nutrients, water, sunlight, pollinators and territory necessary for survival. Evolution of numerous plants has led to development of many different approaches to succeed in this competition.

During the development of farming over the years, utilization of fertilizers, crop rotation, land tillage and use of herbicides to control the unwanted weeds has significantly increased the yield and efficiency of the agriculture. It is estimated that without use of modern agricultural methods the yields would be reduced by 30 – 50%. With continuous growth of the planet population, accompanied by substantial reduction of available crop lands and climatic changes, there is a strong demand for new, more effective technologies for increasing agricultural yield.

Herbicides, also commonly known as weed killers are pesticides used to control the unwanted plants (terrestrial or aquatic). Pesticides are chemicals, which prevent, destroy, repel, or mitigate any pest. Application of herbicides in agriculture offers the farmer crucial advantage to "help" the desired crop to win the essential competition against the weeds.

The lecture will give an overview of herbicides - from basic definitions, through different classifications toward several examples of most known Herbicides.

Synthesis of several active ingredients (as Manufactured by ADAMA) will be discussed. This will demonstrate the challenges ADAMA faces as one of global top producers with regards to synthetic and environmental aspects.

Application of Chemistry to Resolving Crimes

Joseph Almog

Chemistry, The Hebrew University of Jerusalem, Jerusalem, Israel

Forensic Science is the application of science to law. Many crimes would have remained unsolved, and many criminals would escape penalty, without the skillful application of scientific methods, most of which are from the chemistry domain. Moreover, in democratic countries, it is equally important to be able to clear the innocent, which, in many cases would be impossible without the use of appropriate scientific methods. This presentation will survey and briefly discuss some of the most notorious crimes whose decipherment was based on chemical techniques, with particular emphasis on Israeli original developments. The list involves the assassination of the Israeli Minister of Tourism; The homicide and suicide of two celebrities in Jerusalem; Blackmailing of a leading industrialist; and the first identification of the home-made explosive TATP.

The Chemistry of Biologically Produced Minerals

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Structural Biology, Weizmann Institute of Science, Rehovot, Israel

More than 60 different minerals are produced by a huge variety of organisms. Many of these minerals differ substantially from their inorganic counterparts not only in shape and orientation, but in their chemistry. Trace element concentrations, as well as stable isotopic compositions are often controlled by the biology. Many biogenic minerals contain occluded macromolecules that can change their mechanical properties. Even more surprising is that single crystals produced by organisms often have a bulk and surface texture consisting of nano-spheres, quite unlike crystals grown from saturated solutions. This texture is a hallmark of a crystal formation pathway via highly disordered and unstable precursor phases. The precursor phases are composed of nano-spheres that are formed in vesicles inside cells. In fact a surprisingly large variety of cells have such mineral-bearing vesicles, even though they are not known to be directly involved in the formation of mineralized tissues. The involvement of disordered precursor phases in biological crystal formation has inspired many non-biological studies of this phenomenon. These studies have in turn revealed that growth of crystals from precursor phases is widespread and that a common mechanism of growth is by amorphous particle attachment as opposed to ion-by-ion accretion. By understanding these alternate processes and mechanisms of crystal growth both in the inorganic world and in biology, we can better understand the perplexing properties of many biogenic minerals.

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Uncovering the Disguise from Hallucinogenic Synthetic Drugs

Ayelet Ofarim

CAS, Arad-Ophir Ltd., Ramat-Hasharon, Israel

Synthetic drugs are trying to mimic the natural drugs effect. The producers would modify a currently illegal molecule, falling under the drug abuse acts, so that it will not be considered illegal for sale in kiosks, as bath salts, detergents or any other way. The problem is that synthetic drugs often do not fit neatly into one class of drugs for several reasons, including that their precise chemical makeups are often unknown, and their chemical effects on individuals can be both unpredictable and replicative of more than one class of drugs.

How can we identify a suspected drug by searching its chemical general group and find analytical methods to prove its chemical actual identity and bring it to court?



Plenary Lecture
A Journey into Ligands Complexes Catalysts and Polymers

Moshe Kol

School of Chemistry, Tel Aviv University, Tel Aviv, Israel

The possible applications of polymeric materials are derived from their physical properties, derived from their microstructural regularity, derived from the catalysts employed for their synthesis, derived from the metal complexes leading to these catalysts, derived from the choice of metals, the design of the ligands, and the deciphering of their wrapping tendencies.

Over the past two decades, our group has introduced various families of multidentate ligands, well-defined metal complexes, and polymerization catalysts, mostly for the stereoselective polymerization of alpha-olefins, and for the ring-opening polymerization of cyclic esters.

In this presentation we will try to deliver some flavor of catalyst design and polymer synthesis by describing several motifs of our work, including: the design of polydentate ligands, “chirality-at-the-metal”, new polymeric microstructures, polymeryl exchange between two active catalysts, and the application of truly-living polymerization catalysts for the synthesis of accurate stereo-block-copolymers.

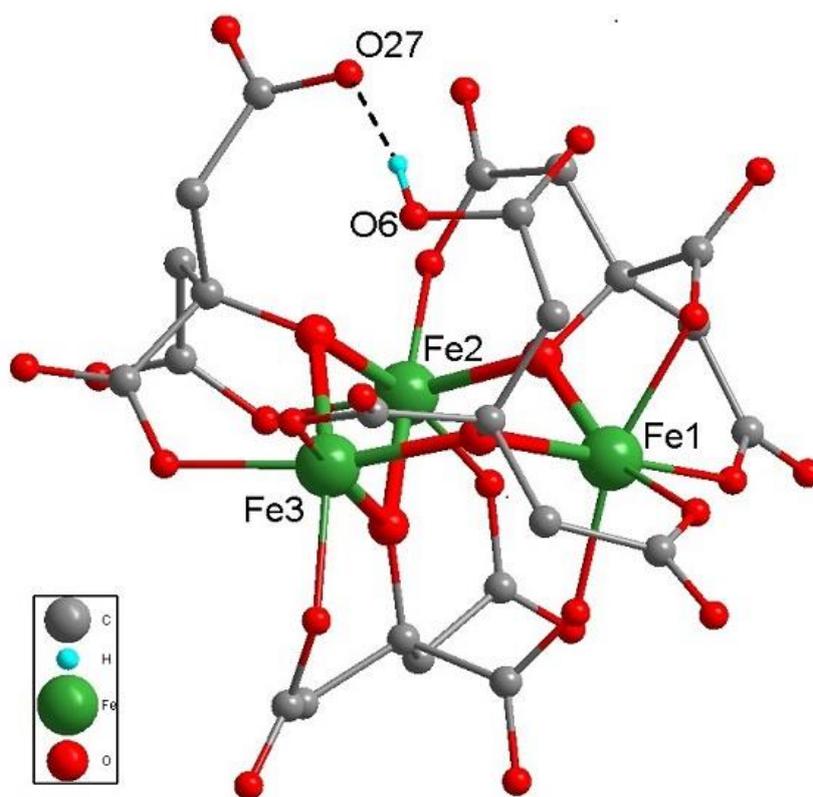
Keynote Lecture

Understanding Ferric Citrate

Avi Bino

Institute of Chemistry, The Hebrew University of Jerusalem, Jerusalem, Israel

Ferric Citrate is a common name of a variety of substances having different structures and iron/citrate ratios. Some of these materials play an important role in biology, medicine and food industry despite the fact that their molecular structure is virtually unknown. In the last two decades we have elucidated the structure of several iron(III) citrate complexes, all of which are polynuclear and contain different iron/citrate ratio. One complex, namely $[\text{Fe}_2\text{Cit}_2(\text{H}_2\text{O})_2]^{2-}$, is recognized and transferred through cell membranes by a specific protein. Ferric Ammonium Citrate is used extensively in medicine as an imaging contrast agent and to treat iron-deficiency anemia. It is also used as an additive in the food industry but its structure and composition remains unknown. We have systematically crystallized species present in the commercial material and present here the molecular structure of the predominant component, a new trinuclear ferric citrate complex.



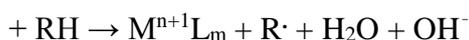
Fenton Like Reactions Proceed Via a Variety of Mechanisms

Dan Meyerstein

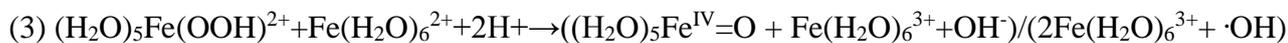
Chemical Sciences Department, Ariel University, Ariel, Israel

Chemistry Department, Ben-Gurion University of the Negev, Beer-Sheva, Israel

The Fenton and Fenton-like reactions are of key importance in biology and in advanced oxidation processes, AOPs. Their mechanism was in debate for many years: the question being whether the active intermediates formed are hydroxyl radicals or $L_{m-1}M^{n+2}=O$ complexes. It is now accepted that usually the mechanism involves two steps:



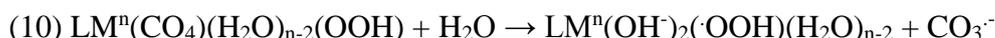
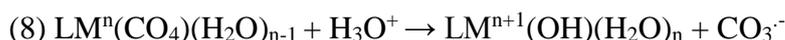
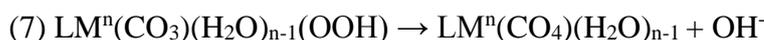
It was also shown that at least for $M = Fe$, in the presence of excess H_2O_2 , the following reaction is of major importance:



Recent results point out that the reactions:



are the source of the ROS when reaction (2) is endothermic. Furthermore, in the presence of HCO_3^-/CO_3^{2-} , which is present in AOPs and in biology, the reactions:



have to be considered. This means that in these systems carbonate anion radicals are the major reactive species.

Furthermore, this means that a ligated peroxide may oxidize another ligand without oxidizing the central cation. DFT examples for these possibilities will be presented.

Molecular Principles Underlying Biomineralization Pathways and Biomimetic Strategies by Solid State NMR

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Technion - Israel Institute of Technology, Haifa, Israel*

²*Department of Chemistry & Chemical Biology, Cornell University, Ithaca, New York, USA*

Biomineralization provides numerous and diverse examples where organisms have optimized processes of growth of solid nanophases, both crystalline and amorphous, so that high-performing ceramics are synthesized at ambient temperatures in aqueous conditions yielding materials that are functionally-tailored. Essential to the process is control over all aspects of the resulting biogenic inorganic material, from molecular structure and composition through macroscopic shape, morphology, mechanical and optical properties, stability and more. Of key importance is the elucidation of the atomistic details of the resulting *intact* biominerals, and of the mechanisms which encode functionality into these materials; e.g. which imprint either for stability or metastability. Many methodologies provide access to mineral properties as a function of growth conditions; but their characterization in terms of atomistic structures and interactions is difficult to address except by solid-state NMR (ssNMR). Our NMR studies expose the structural-chemical state of inorganic-bioorganic *interfaces*, as in “intracrystalline” mineral-occluded bioorganics, where we directly probe their chemical identity and the interactions between the different components and follow them forward as the materials form, phase separate or transform despite their low concentration, their fundamentally disordered nature, and that they are buried within bulk matrices.

Earlier molecular insights into the mechanisms employed by coccolithophores (intracellular construction of calcitic coccoliths) and fresh water crayfish (gastroliths - storage organs of bioavailable amorphous calcium carbonate, ACC) will be reviewed. Following, I will describe recent *in vitro* studies of the mechanisms by which phosphate and water molecules regulate the stability of ACC, and by which biomolecules (Asp, Glu) in the precipitations solution and therein occluded in the lattice control and imprint its characteristics. Both *in vitro* biomimetic model systems demonstrate fundamental biomineralization pathways.

Keynote Lecture

High Rate Pseudocapacitive Energy Storage in Transition Metal Oxide (TMO) Electrodes for Aqueous Supercapacitors

Ervin Tal-Gutelmacher

C.T.O., PO-Celltech Ltd., Cesarea, Israel

With global energy consumption constantly on the rise, alternative energy storage solutions are in high demand. The electrification of the transportation industry and the continued push for green energy has spurred the automotive and transportation market to seek improved energy storage elements that combine both high energy and power – and are available in a smaller size and at a lower cost. TMOs exhibit various oxidation states, and the charge transfer between them can be exploited in reversible redox reactions. This faradaic charge storage mechanism, so called pseudo-capacitance leads, in combination with the conventional double layer charging, to an increased charge storage capacity of the device. Also, the kinetics for electrolyte decomposition depend strongly on the electrode material, and it has already been demonstrated that metal oxides have the potential to increase the available electrochemical window in SC leading to an increased operating voltage and higher power and energy densities. In this talk an overview on the advantages and innovation of our high rate aqueous pseudo-capacitor will be outlined, with specific emphasis on the design and development of novel TMO composite materials for enhanced and reliable performance.

Chemistry in DataCenters: bottom up meets Top Down

Elad Mentovich

Process Technologies, Mellanox Technologies, Yokneam, Israel

Currently, (Silicon) Photonics is widely used in today's Datacenters (DCs). We will review the state-of-the-art of materials used in photonic interconnects in DCs today and some of the challenges towards achieving even higher switching rate. The possibility of utilizing advanced materials for breakthroughs in DCs will be discussed as well.

Latent Incompatibility of Stainless Steel with Lead Azide Primer – A Case Study

Rivka Efrat¹, Valentina Borgel¹, Mario Silberman¹, Gregory Gershinsky², **Eran Tuval**¹

¹*Ground Forces, Technology Division, IDF, Ramat-Gan, Israel*

²*Chemistry, Bar-Ilan University, Ramat-Gan, Israel*

While designed to be lethal, army ordinance ammunition must also be safe to store, transport and deploy, maintaining chemical and physical stability for many years.

The chemical compatibility between lead azide primary explosive and its X8CrNiS18-9 1.4305 grade stainless steel was investigated under accelerated weathering conditions that eventually introduced an ion conducting environment.

The scope of the research is to chart possible, practical, chemical causes leading to the migration of copper from the stainless steel metal lattice, where the concentration is a mere 0.4%, into solution with the lead azide forming the extremely sensitive and unpredictable copper azide.

The resulting incompatibility is very dangerous, yet, not evident - thus best described as "latent incompatibility."

In the case study presented a lead azide primer was subjugated to weathering while in intimate contact and indirect contact to X8CrNiS18-9 1.4305 stainless steel. The resulting products of the reaction were carefully characterized to detect suspected copper azide by means of advanced spectroscopic apparatuses (ICP, XRD), SEM and light microscopy.

The work shows concisely that X8CrNiS18-9 1.4305 stainless steel lends itself to migration of copper from the metal lattice into solution with the azide primer, where due to strange affinity, will replace lead ions to form copper azide (or more precisely cupric azide).

Keynote Lecture

The Nanostructure of Complexes Formed by Oppositely Charged Amphiphiles and Polyelectrolytes

Yeshayahu Talmon, Moar Ram-On, Yachin Cohen

*Chemical Engineering and the Russell Berrie Nanotechnology Institute (RBNI),
Technion - Israel Institute of Technology, Haifa, Israel*

The interaction between amphiphiles and polyelectrolytes has been widely investigated in recent years due to their potential application in industry and medicine, with special focus on gene therapy. The cationic lipid dioleoyl trimethylammonium propane, DOTAP, and the oppositely charged polyelectrolytes, sodium poly(acrylic acid) and sodium poly(styrenesulfonate), form multilamellar complexes in water. Due to the different molecular stiffness of the two polyelectrolytes, they form different nanostructured complexes. Also, because of different ionization behavior of the two polyelectrolytes, pH affects differently the complexation of the polyelectrolytes with didodecyldimethyl-ammonium bromide (DDAB), another cationic surfactant. We used cryogenic temperature transmission electron microscopy (cryo-TEM) and small-angle x-ray scattering (SAXS) to compare the nanostructures formed in those systems. Our results show that although the basic nanostructures of the complexes are always lamellar (multilamellar or unilamellar), the morphology of the complexes is affected by the polyelectrolyte rigidity and the solution pH. The work has been extended to the study of the complexation of protein with cationic lipid, an important issue for gene therapy.

Novel Optimized & Versatile Surface Chemical Engineering of Mechanically Robust Inorganic Tungsten Disulfide (WS₂) Nanotubes (f-INT-WS₂) - Potentiality for Nanoscale CNTs Replacement

Jean-Paul (Moshe) Lellouche

*Department of Chemistry & Institute of Nanotechnology & Advanced Materials,
Bar-Ilan University, Ramat-Gan, Israel*

An innovative method of chemically versatile surface functionalization (**polycarboxylation – sidewall polyCOOH shell**) of tungsten disulfide (WS₂) multi-walled inorganic nanotubes (INTs-WS₂) has been successfully developed based on *N*-relating strongly electrophilic species (*imminium salt chemistry*). This newly developed nanotube sidewall multi-parametric polyCOOH functionalization has been also globally optimized (Design of Experiments statistical method, DoE optimization). Thus, it enabled an extremely wide chemical versatile range of various 2nd step surface engineering/derivatization reactions (covalent attachment of proteins, peptides, small ligands, etc...). Indeed and for example, it provided various attractive *covalent* INTs-WS₂ chemical surface modifications (**polyNH₂**, **polyOH**, **polySH** as 1st series of shells examples) *via* (i) polyCOOH chemical activation (EDC, CDI) and (ii) 2nd step nucleophilic substitutions by short ω-aminated ligands H₂N-linker-**X**, **X** outer surface functionality). Resulting fully characterized functional INTs-WS₂ (f-INTs-WS₂) nanotubes have a quite wide potential for use as **novel functional nanoscale inorganic fillers** toward new mechanically strengthened composite polymeric matrices/coatings. These novel functional nanoma-terials/”nanoscale fillers” have been also shown to be non-toxic in preliminary toxicity studies, which opens a wide R&D route/progress for corresponding appropriate end-user applications as CNTs replacing non-toxic inorganic nanofillers.

Anionic Boron Cluster Compounds: Self-Assembly without Head-Tail Structure, and Amphidynamic Nature of their Polymeric Nanocomposites

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²*Institute of Macromolecular Chemistry, Academy of Sciences of the Czech Republic, Prague,
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³*Stranski-Laboratorium für Physikalische Chemie und Theoretische Chemie,
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We report an experimental evidence that the anionic boron clusters form multimolecular aggregates in solution,[1] and are surface active despite an absence of a hydrophobic tail as compared to classical surfactants.[2] The studied compounds comprise the boron clusters of various hydrophile-lipophile balances: from small and hydrophilic decaborate with high charge density (resembling thus hydrotropes) to bulky and hydrophobic metallacarborane (behaving like surfactants). The aggregation takes place regardless of the exoskeletal substitution or the presence of C-H units within the cluster. The driving force for all above-mentioned processes is closely related with a non-classical hydrophobic effect.

New polymeric nanocomposites based on interaction of metallacarborane, cobalt bis(dicarbollide)(-1), trivially called COSAN, with polycations poly(2-vinyl pyridine), P2VP and poly(4-vinyl pyridine), P4VP, and neutral poly(ethylene oxide), PEO, were prepared. While P2VP/COSAN and P4VP/COSAN nanocomposites are fully amorphous, PEO/COSAN exhibits narrow reflections in WAXS pattern indicating a certain degree of inner organization. More details on the inner structure and segmental motions were obtained by ss-NMR. The structure of PEO/COSAN is unique, where Na⁺ and COSAN⁻ are evenly dispersed within the amorphous PEO matrix. Both P2VP and P4VP matrix is fully charged and protonized. Due to the bulkiness of COSAN clusters and their different accessibility to positively charged nitrogens in P2VP and P4VP isomers. The ability of COSAN to rotate is also different for all the studied nanocomposites, the systems can be therefore called as amphidynamic ones resembling molecular rotors.[3]

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Keynote Lecture

Computational Studies of CFTR, an Ion Channel Implicated in Cystic Fibrosis

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Cystic Fibrosis (CF) is a lethal, incurable genetic disease with a median lifespan in the late thirties. Currently, the worldwide number of CF patients is estimated at 70,000 with about 600 in Israel. CF is caused by mutations to the CFTR chloride channel, a member of the ABC transporters family. Over 2000 mutations of CFTR were reported with different prevalence and mechanisms of action. All mutations compromise the ability of the channel to transport chloride ions across cell membranes thereby disrupting the ion-liquid balance across the epithelial cells lining the respiratory system. This leads to dehydration of the mucus layer lining the lungs and to its colonization by bacteria, ultimately resulting in chronic lung disease and lung failure.

Developing effective therapies for CF would be greatly advanced by high resolution structural, functional and energetic characterization of full length CFTR and its domains and by the understanding of the effects of clinical mutations as well as drug interactions.

With this in mind, we present a series of computational studies demonstrating the ability of molecular modeling tools to probe the structure, dynamics, and drugability of CFTR and its domains [1-3]. We will also present new CFTR models generated by using Molecular Dynamics Flexible Fitting simulations. These models take advantage of recent developments in Cryo electron microscopy (EM) leading to EM maps of increasingly higher resolutions. Lessons learnt from CFTR may be transferable to other ABC transporters implicated in diseases.

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New Insights on NiOOH Catalysis from Theory

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The computational design of solid catalysts has become a field of great interest during the last decades. With the recent increase in computational tool performance, new insights can be obtained by modelling the electronic structure of catalytic materials. Specifically, the electronic structure implications on catalysis for NiOOH, one of our best water oxidation catalysts will be discussed. Key issues include: band edge positions, band edge chemical character, metal-oxygen bond ionicity, and catalytic overpotential. Our results suggest that chemical activity of NiOOH can be controlled by composition design strategies.

References:

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Insight into the Thermal and Light-Activated Isomerization in Rhodopsin from QM/MM Simulations

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The primary event of vision in the vertebrate eye is the highly selective and efficient photoisomerization of 11-*cis*-retinal protonated Schiff base bound to the visual protein rhodopsin (Rh). We investigated the possible consequences of the charge translocation associated with the photoisomerization.¹ We show that the evolution of the electrostatic potential (ESP) projected by the chromophore onto the surrounding protein (Fig. 1) displays intense but topographically localized sudden variations in proximity of the decay region.² pKa calculations carried out on selected snapshots and used as probes, indicate that the only residue which may be sensitive to the electrostatic potential shift is Glu181. Accordingly, our results suggest that the frail Tyr191/268-Glu181-Wat2-Ser186 hydrogen bond network may be perturbed by the transient variations of the electrostatic potential.

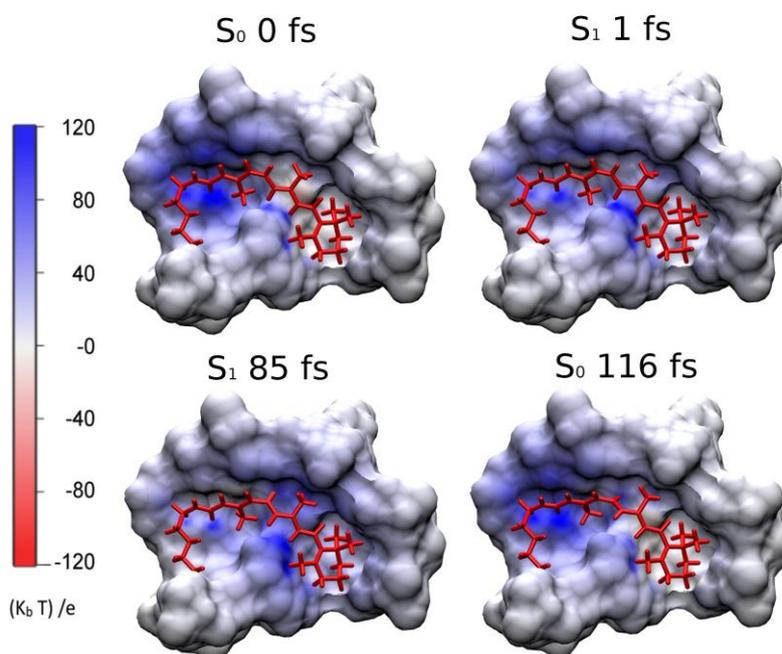


Figure 1 Trajectory snapshots documenting the ESP change on the chromophore cavity of bovine Rh.

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Keynote Lecture
**Waste is an Eco-Friendly and Economically-Viable Source for Production of
Premium Liquid Fuels**

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Synthetic liquid fuels and chemicals produced from renewable and alternative feedstocks are essential components of the future transportation and commodities outlook. The potential feedstocks for large-scale production of synthetic fuels are divided into three groups: fossil (natural gas and coal), biomass and carbon dioxide combined with a hydrogen source, mainly water or natural gas. Conversion of natural gas and coal is mostly practiced through a combination of catalytic gasification and Fischer-Tropsch synthesis (FTS). Biomass is converted to liquid fuels by thermal, catalytic and biological processes. The most abundant raw materials – carbon dioxide and water – are definitely attractive eco-alternatives.

The Blechner Center (<http://www.bgu.ac.il/indcat/>) has developed, over the past two decades, a wide variety of technologies in the area of alternative fuels and chemicals. Integrated catalytic technologies for conversion of CO₂/CO/H₂ mixtures to fuels and chemicals are ready for demonstration and commercialization.

The keynote lecture will focus on existing and foreseeing catalytic processes for converting alternative and renewable feedstocks to liquid fuels and chemicals.

The Chemistry of Colored Diamonds

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Carbon has two major allotropic forms: graphite which is the thermodynamic stable form at 1 atmosphere pressure and diamond which is the stable form under very high pressure conditions. Thus at 120-150 km below the earth crust at 2-3 MAt pressure and ~1,200C, diamonds are the basic form of carbon.

Fortunately, when diamonds are ejected to earth surface via volcanic eruptions, if the diamond cools down fast, the slow kinetics of oxidation to carbon dioxide or transformation to graphite keeps the gems to survive as diamonds at 1 At pressure.

Most diamonds are colorless with a very high refraction index of 2.43. However colored diamonds (defined in the jewelry industry as Fancy Diamonds) are known, though these gems are rare and much more expensive than regular diamonds. The main source for color in diamonds is the presence of small concentrations of nitrogen atoms (100ppm) in the crystal structure, though in few cases boron can induce some blue grey color. Nitrogen can occur in 10-15 forms in the crystal structure and every form causes different optical properties of the diamond. Thus red, blue, yellow, green and almost every other color is known.

The presentation will discuss what nitrogen structures are responsible for any color and how chemical treatments (e.g. high temperature, pressure, radiation etc.) can change the nitrogen form of the N contaminated diamonds to the desired color and what analytical and chemical techniques are used for the process. Also samples of different colored diamonds will be presented.

Keywords: *diamonds, colored diamonds, chemical treatments of diamonds, HPHT process*

To Process or Not to Process Foods? Engineering the Physicochemistry and Digestibility of Food

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In the dichotomous world of overweight and malnourished populations, there is an evident need for safe, wholesome, pleasurable and affordable foods. Modern food production offers various benefits to the consumer, including inactivation of food pathogens, convenience, preservation and delivery of bioaccessible macro- and micro-nutrients. However, there are still gaps in our understanding and control over the complex compositions, structures and chemical reactions occurring in foods during processing, shelf life and in the human body.

This lecture will provide attendees a taste from various studies opening new paths to control or direct macronutrient digestion or the release of nutraceuticals. First, the use of starch, a staple food carbohydrate, will be presented as a bio-inspired platform for the nano-encapsulation and controlled delivery of lipophilic ingredients. Second, the thermally-induced amino-carbonyl reactions, also known as the Maillard reaction (MR), will be discussed as a green chemistry pathway towards unintentional or deliberate modifications of the functionality of edible proteins. Particular emphasis will be drawn to the extra-nutritional role of proteins as antioxidants and precursors of bioactive peptides. This part will also detail how Maillard reaction products may be differentially digested in infants and adults. Last, MR will be described as a way of glycosylating edible proteins and then rationally using them to modify lipid droplet interfaces and consequently their digestive fate. Overall, this talk will expose attendees to examples demonstrating how to harness soft matter and applied chemistry principles and tools to tackle the complex challenges of engineering foods to meet consumer needs, acceptance and preferences for natural products that promote health and well-being.