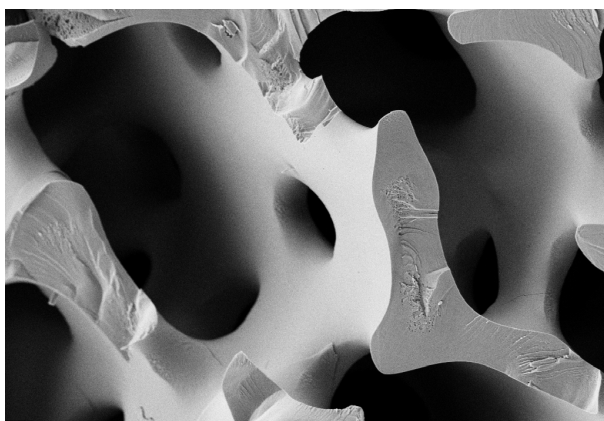


PL01
POLYMERS AND CRYSTALS –
A HAPPY MARRIAGE

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Biominerals are remarkable materials with complex and often hierarchical structures (see image of sea urchin spine below) and superior physical properties compared to man made materials made at ambient conditions in aqueous environment. Biominerals are organic-inorganic hybrid materials and the crystallization of the inorganic mineral is highly controlled by organic – usually polymeric additives. The formation processes of Biominerals can be mimicked, which is the field of polymer controlled crystallization or bio-inspired mineralization. Polymers can have different and often multiple roles in a crystallization process. They can be a scaffold for mineral formation, complex ions, inhibit or enhance crystal nucleation, stabilize amorphous precursor faces, selectively adsorb on crystal faces changing their morphology, encode self organization of nanoparticles and many more. Examples for the various roles of polymers in crystallization processes to generate crystals with complex structures are given. Especially coding of nanoparticles by polymers for subsequent tailored aggregation of nanoparticles is an attractive new research field summarized as *Nonclassical Crystallization*. This crystallization path is based on nanoparticles instead of ions, atoms or molecules and offers new possibilities for the formation of crystals. These possibilities will be discussed too.



Microstructure of a sea urchin spine (Scanning electron micrograph). Although the spine has the properties of a single crystal, its morphology exhibits no crystal faces which are typical for single crystals.

PL02
MESOSCOPIC ELECTRODES FOR GENERATION
AND STORAGE OF ELECTRIC POWER FROM
SUNLIGHT

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The lecture covers our recent research on mesoscopic electrodes that made up of a network of nanometer-sized particles such as titanium dioxide, zinc oxide, tungsten trioxide, Fe_2O_3 or LiMnPO_4 . The pores between the particles are filled with an electrolyte or p-type semiconductor, in this way interpenetrating bicontinuous network composites are formed which are phase-separated by a hetero-junction. Electrons can percolate rapidly across the network of nanoparticles allowing the huge junction area to be addressed electronically. Intriguingly, cross surface electron and hole transfer in self-assembled monolayers (SAM) of redox-active molecules has also been observed. These mesoscopic oxide electrodes show great promise for a number of applications, such as high power lithium insertion batteries photo-electrochemical cells for solar hydrogen generation and dye-sensitized solar cells (DSCs). The DSC achieves currently a conversion efficiency of over 11 percent and exhibits excellent long term stability, rendering it a credible alternative to conventional silicon based devices. These new cells offers opportunities for applications in building integrated photovoltaic device and light weight solar power supplies. Recently large-scale production of flexible DSC modules has started.

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PL03
GLASSES FOR SEEING BEYOND THE VISIBLE

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Our perception of the world is mainly due to the highly sophisticated optical performances of our eyes which allow us to sense the beauty of the so-called colours which extends from the blue to the red. This visible domain is just a very small part of the light spectrum which extends beyond the red, far to the infrared which is indeed the world of heat and the region of the vibrations signature of molecules.

In the last three decades tremendous progress has been accomplished towards visualizing this IR light by developing new glass optics as well as detectors playing the role of retina but operating beyond the visible The main strategic spectral

region is located around 10 μm where the atmosphere is transparent and which corresponds to the maximum emission of a thermal object at room temperature. The only glasses suitable for infrared optics are made from the chalcogens S, Se and Te associated to neighbours having the same electro negativity in order to produce polymeric glass forming network

IR lenses as well as IR optical fibres are now coming into the market for night vision system aiming at assistance in driving car in dark and foggy conditions as well as detecting hot objects.

The *in-situ* detection of molecules or bio-molecules using IR glass fibres have found applications in medicine and biology for the early detection of metabolism dysfunction, as well as in chemistry to elucidate some reactions mechanisms.

IR fibres with a specific optical configuration are also candidates in astronomy for detecting signs of life on earth like exoplanets.

Recent advances in infrared materials and devices with applications in night vision, medical and space applications as well as green house gas detection such as carbon dioxide will be presented.

PL04 MOLECULAR ROTORS AND BUBBLES

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We describe the preparation of artificial dipolar molecular rotors of both azimuthal and altitudinal types, their mounting on surfaces, and characterization of the resulting structures by both spectroscopic and scanning microscopy techniques. The synthesis of the molecular rotors, which was initially performed using standard classical synthetic procedures, has more recently explored possibilities offered by molecular self-assembly followed by covalent stabilization.

We further describe attempts to arrange azimuthal dipolar rotors on a surface in a regular triangular array and to measure the barriers to rotation by methods of dielectric spectroscopy. The ultimate goal is a fabrication of an artificial ferroelectric film with minimal barriers to rotation and a controlled rate of propagation of an orientational wave front, which could be useful in nanoelectronics.

In the course of work on the project we noted that nitromethane solutions of certain self-assembled trigonal prismatic structures whose shape resembles an open trigonal tube have unusual properties that suggest that the tube contains a void, although it has space for a dozen solvent molecules and wide enough entrances for easy solvent access. The results have been modeled with methods of molecular dynamics. We propose that the behavior may have some generality and can be understood in terms of nanocapillarity.

PL05 INTERSTELLAR MOLECULES – MODELS FOR NEW CHEMISTRY

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The interstellar space is one of the most remarkable chemical laboratories. The existence of a number of species with low valent elements has been characterized by scientists from astrophysics. Therefore it is a challenge for a chemist to prepare compounds with low valent elements in the laboratory and study their chemistry.

We were able to prepare and study the chemistry of aluminum(I), silicon(I), silicon(II), germanium(I), germanium(II), and tin(II) compounds. The low valent state can be arrested by using sterically bulky ligands or base stabilizing procedures.

Methods for the preparation of compounds with the following composition $\text{NHC}\cdot\text{SiCl}_2$ (NHC = *N*-heterocyclic carbene), LSi(II)H (L = monovalent amidinate), LSi(II)F , LSi(I)-Si(I)L will be given, and their reactions with ketones, alkenes, partly- and per-fluorinated aromatics, 2,3-dimethylbutadiene, azobenzene, and diazo compounds are reported. In the case of germanium and tin the monohydrides of composition LM(II)H (L = β -diketiminato, M = Ge, Sn) have been prepared. Due to the larger radius of the M(II) in comparison with the M(IV) cations, the compounds show an increased reactivity. For example LGeH and LSnH react below room temperature with CO_2 under insertion into the metal-hydrogen bond. Comparable reactions with M(IV) species need an additional transition metal catalyst.

Furthermore, perfluorinated aromatics can be converted selectively to the monohydrides using Group 14 hydrides with low valent elements.

The X-ray structures and bonding properties of these new species will be discussed.