Ph.D. Course in Materials Science and Nanotechnology

University of Milano-Bicocca, Department of Materials Science, via Cozzi 55, 20125 Milano

February 21, 2020 – 3.00 p.m.
seminar room - U5

Panče Naumov

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Dynamic Molecular Crystals: The Bigger Picture

Mechanically reconfigurable molecular crystals—ordered materials that can adapt to variable operating and environmental conditions by deformation, whereby they attain motility or perform work—are quickly shaping up a new research direction in materials science, crystal adaptronics. Properties such as elasticity, superelasticity and ferroelasticity that are normally related to inorganic materials, and phenomena such as shape-memory and self-healing effects which are well established for soft materials, are increasingly reported for molecular crystals. Yet, their mechanism, quantification, and relation to the crystal structure in organic crystals are not immediately intelligible to the chemistry and materials science research communities. This lecture will provide a condensed topical overview of the elastic, plastic, salient, superelastic and explosive molecular crystals, emerging new classes of materials that bridge the gap between the soft matter and inorganic materials. The occurrence of these unconventional properties, the underlying structural features, and the global performance indices that are essential to assess their potentials for applications will be discussed with prominent recent examples.

February 21, 2020 – 4.00 p.m.
seminar room - U5

N. B. McKeown

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Porous materials without a framework

Conventional nanoporous materials are stabilized by a framework of covalent bonds and so are not soluble or solution processable. Instead, we aim to make nanoporous materials from discrete molecules or macromolecules. For example, Polymers of Intrinsic Microporosity (PIMs) are non-network materials that generate porosity from their rigid and contorted macromolecular chains. The combination of microporosity, chain rigidity and solution processability facilitates applications of PIMs in sensors, for which a commercial device now exists, and as membranes for separations. The emerging structureproperty relationships for PIMs will be discussed including the design concept of using 2D chains to enhance intrinsic microporosity to achieve ultrapermeable polymers for selective gas separations.

In addition, we are interested in porous molecular crystals composed of discrete molecules, between which there are only non-covalent interactions. We have demonstrated that the macrocycle 2,3,9,10,16,17,23,24-octa(2',6'-di-iso-propyl-phenoxy)-phthalocyanine, even with a large diversity of central metal cations and attached ligands, dependably forms molecular crystals containing massive solvent-filled interconnected voids of >10 nm3 volume. Strategies to stabilize these porous molecular crystals using molecular wall-ties, including fullerenes, will be discussed together with their potential applications as magnetic materials and catalysts.