1**RESEARCH FIELD:**

Mineralogy, Structure of materials.

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RESEARCH TOPIC:

Pressure-induced organized nanostructures and shape-driven segregation in zeolites

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PARTICIPANTS:

Dr. Rossella Arletti, Dr. Roberto Giustetto, Dr. Linda Pastero

COLLABORATIONS:

Università degli Studi di Torino, Dipartimento di Chimica,

Università degli Studi di Milano, Dipartimento di Scienze delle Terra,

Università dell'Insubria, Dipartimento di Scienza e alta tecnologia

Università degli Studi di Modena e Reggio Emilia, Dipartimento di Scienze Chimiche e Geologiche

European Synchrotron Radiation Facility (Grenoble), Institut Charles Gherard (Montpellier)

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RESEARCH DESCRIPTION:

In this research we intend to investigate and understand the behavior of molecules and porous materials under the combined effects of applied pressure, spatial confinement and constraints in morphology at the nanoscale . such a "hyperconfinement" regime will be exploited to create supramolecular organization, new nanosystems of controlled morphology and, at the same time, to extend the application range of a class of materials of outstanding relevance for innovative technologies by improving their functional properties.

The hyperconfined systems will be synthesized in the form of ordered arrays of nanosized supramolecular aggregates, by adopting a simple bottom-up approach: molecular building blocks, dissolved in a liquid medium, will be "injected" in zeolite cavities by applied pressures up to 10 GPa. The peculiarity of zeolites of being crystalline pressure-resistant nanostructured moulds will be exploited to achieve pressure-induced segregation and organization of the molecular building blocks in shape-controlling arrays of nanosized cavities. Achievement of these goals would lead to a set of practical strategies to produce template- and pressure-driven synthesis of ordered architectures of nanosized supersystems, where hyperconfinement effects might be thoroughly tested and investigated. The physico-chemical characterization of these materials will be performed

by adopting a multi-technique approach based on the integration of experimental and theoretical methodologies.
We will also study the pressure-induced effects on organic-inorganic hybrid microporous materials currently applied in strategic areas, from sustainable energy technologies to biomedical sciences. Specifically, we will focus on host-guest dye-zeolite L hybrids, where the photoactive molecules are organized in one-dimensional nanostructures inside the zeolite channels. The excellent optical properties, chemical stability and biocompatibility of these composites make them key components of artificial antenna systems, sensors, light emitting and bionano devices, such as in-vivo markers of tumor cells. Owing to the relevance of dye-zeolite L hybrids for “environmental sustainability” and “human health we will study their response to high pressure conditions. We plan to exploit irreversible changes of the optical properties, which could improve their functionality, in order to expand the applications of this technologically strategic class of materials. (research project financed in the frame of FIRB FUTURO IN RICERCA 2012)

Links:

http://www.impact-firb.it

http://www.torinoscienza.it/articoli/in_arrivo_i_nanomateriali_del_futuro_24349

http://rassegnastampa.unipi.it/rassegna/archivio/2012/12/12SIC3006.PDF

http://www.impact-firb.it

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2LABORATORIES OF THE DST IN USE:

Powder diffraction, Sinth

1RESEARCH PRODUCTS:

•Arletti, R., Quartieri, S.,G. Vezzalini (2010) Elastic behaviour of zeolite boggsite in silicon oil and aqueous medium: a casa of high pressure induced over-hydration, American Mineralogist American Mineralogist, 95, 1247-1256

•Arletti, R., Vezzalini, G. Morsli, A., Di Renzo, F., Dmitriev, V., Quartieri, S. Elastic behavior of MFI-type zeolites: 1- Pressure-induced over-hydration of Na-ZSM-5 (2011)Microporous and Mesoporous materials, 142, 696-707

•Quartieri, S., Montagna, G., Arletti, R., Vezzalini, G. (2011) Elastic behavior of MFI-type zeolites: Compressibility of H-ZSM-5 in penetrating and non-penetrating media J. Solid State Chem. , 181,1505-1516

•Martucci, A., Pasti, I., Nassi, M., Alberti, A., Arletti, R., Bagatin, R., Vignola, R., Sticca, R., (2012) Adsorption mechanism of 1,2-dichloroethane into an organophilic zeolite mordenite: A combined diffractometric and gas chromatographic study, Microporous and mesoporous materials, 151, 358-367

•Quartieri, S., Arletti, R., Vezzalini, G., Di Renzo, F., (2012) Elastic behavior of MFI-type zeolites: 3- compressibility of silicalite and mutinaite, J. Solid State Chem. 191, 201-212

•Arletti, R., Martucci, A., Alberti, A., Pasti, L., Nassi, M., Bagatin, R., (2012) The location of MTBE and toluene in the channel system of the zeolite mordenite: adsorption and host-guest interactions J. Solid State Chem., 194, 135-142

GROUP CONTACT: Rossella Arletti