

## THEME 1: THE DYNAMIC SOLID

### Session 1.6:

### Nano-scale properties of materials

#### CONVENED BY:

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The recent upsurge in research in the general area of nanoscience is well reflected in the geosciences. Nanominerals constitute a unique class of Earth materials and play an important role in important physical and chemical properties of natural systems. They form through a variety of processes and range from crystalline nuclei in volcanic glasses and low temperature nano-scale minerals to amorphous materials, colloids, and biomolecules which interact with minerals. The objective of this session is to discuss and present recent advances in understanding the unique properties of natural nano-materials: interactions between nano-scale materials, between them and larger particles, materials reactivity (including solubility, charging, charge transfer, solute transport and trapping of contaminants) magnetic and optical properties, quantum size effects and photo-chemical properties. We encourage contributions on the relationships between physical/chemical and structural properties, formation conditions and stability, novel crystal growth mechanisms or composition of nano-scale minerals. This session aims to bring together researchers in geochemistry and mineral physics, materials science and environmental science.

### 1.6.11

## Nanomineralogy – low-cost nanotechnology of the future

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Nanomineralogy at the Karlsruhe Research Center represents an interdisciplinary field of fundamental research and applied sciences with groups from different disciplines cooperating with partners from industry. This allows for the basic understanding of properties and the development of new technical applications that are oriented to meeting a real demand.

Our vision is to modify and tailor naturally occurring nanominerals as a low-cost basic material for new products.

Current activities in this direction therefore focus on clay minerals and hydroxides as the most abundant minerals on the Earth's surface. Most of these minerals are of a size that is considered to be "nano". In nature, however, these nanominerals are aggregated and their properties are determined by the bulk material, e.g. clay. The first challenge now is to separate and delaminate the bulk material into fundamental particles and to preserve them as nanominerals. The overall objective is to use existing feedstock as an unlimited source of low-cost nanominerals.

Nanomineral extraction and the investigation of structural properties and interactions with other systems are the current research fields of nanomineralogy at the ITC-WGT. Mineral properties are defined on the nanoscale, most of them being very promising for technical applications in e.g. cosmetics, packaging, and construction materials.

Nowadays, understanding of nanominerals and their particular properties is rather limited. Production of new products requires knowledge of the mechanisms involved in the interaction of nanominerals with other materials, e.g. polymers. Final characteristics and properties of such nanocomposites also depend on the nanomineral-based substrate.

Another important aspect of nanotechnology is the formation of ordered structures on the nano to submicron level. Structuring processes, such as self-assembly and self-organization which create highly complex structures in nature, play an important role e.g. in crystallization and are subject of our research. Presently, these processes are being used in the nanostructuring of layer double hydroxides. Here, periodic structures are applied as templates for the formation of ordered structures on a higher level, e.g. proteins.

Our achievements include the chemical delamination of mica with divalent cations, the production of different kaolinite/polymer nanocomposites, and the magnetization of any non-magnetic material, e.g. TiO<sub>2</sub>, with nano-sized green rust in the form of aggregates.

At the Forschungszentrum Karlsruhe, a strong nanomineralogy group was established in early 2001 by a cooperation of universities, research facilities, and partners from industry.