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MICRO- AND NANOSTRUCTURES BY COLLOIDAL ROUTES

Contact person: Terezia Nyari (nyarit@icmct.uvt.ro)

Objectives: An interdisciplinary approach of the colloidal routes (bottom-up) for obtaining micro- and nanostructures; new materials for photonics, solar energy conversion, and sensing applications; modeling and simulation of nanosystems.

Preliminary results: Colloidal synthesis of $CuInS_2$; PBG width calculus in photonic crystals.

Applications: photonics, solar energy conversion, sensors.

Collaborations: Technical University of Moldova, Chisinau; "Politehnica" University of Timisoara, Dept. of Chemical Engineering; Romanian Academy - Timisoara Branch, Anorganic Chemistry Lab.

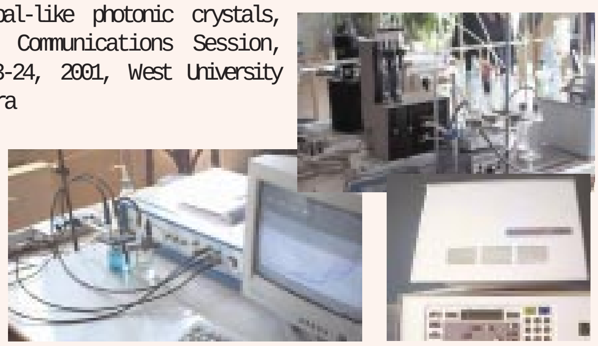
Publications:

1. T. Nyari, P. Vlazan, Z. Szabadai (2002) Colloidal synthesis of ternary copper chalcogenide semiconductor nanoparticles, 8th Int. Conference on Colloid Chemistry, sept. 18-20, 2002, Keszthely, Hungary

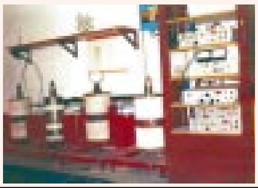
2. T. Nyari, P. Vlazan, A. Farkas, O. Sandru (2002) Colloidal synthesis of SiO_2 nanoparticles with high monodispersity, Sesiunea de comunicari stiintifice „ICMCT - 10 ani", iulie 2002, Timisoara

3. N. Pricopi, T. Nyari (2001) Photonic Band Gap theoretical approach for some colloidal crystals, International Conference on Materials Science and Condensed Matter Physics „MSCMP 2001",5-7 july 2001, Chishinau, R. Moldova

4. T. Nyari, N. Pricopi, I. Hrianca (2001) Photonic band structure of TiO_2 opal-like photonic crystals, Physics Communications Session, nov. 23-24, 2001, West University Timisoara



HYDROTHERMAL SYNTHESIS OF SINGLE CRYSTALS OR NANOCRYSTALS UNDER HIGH PRESSURE AND TEMPERATURE (3000 bar, 6000C)



Contact person: Dr. Ioan Grozescu (grozescu@icmct.uvt.ro)

Description:
Eight laboratory autoclaves having capacity between 0.1 and 1 dm3 are used for the study of solubilization and crystallization at high-temperature (up to 600 C) and high-pressure (up to 2500 bar) aqueous solvents solutions to grow new single or nano crystals;
A pilot installations (100 dm3) that allow us to apply the results of research in production.
The main parts of this installation are: the autoclave, the heating system, the Bridgmann etching system, the thermal isolation system and the command-control-displaying system.

Application of these installations:
These installations are specially used for obtaining single or nanocrystals of materials that present polymorphous changes at low temperatures. These polymorphous changes induce irreversible structural modifications, which affect the physical properties of the material.

It was obtained:
- a-SiO_2 single crystals, size 200x80x60 mm, Y-cut, Q=2,4x10-6 (fig.1);
- doped -SiO_2 single crystals, using Ti, Al, Cr or Fe as dopant;
- single crystals of a-$AlPO_4$, unused size for devices applications (under 3 mm);
- $BaTiO_3$ powder, hydrothermal synthesis at low temperature.

It is going to start a research project for obtaining:
Some oxidic nanocrystals (TiO_2, CeO_2, ZnO, etc.);
Exotic materials: GaN or GaAl.

RF PLASMA INSTALLATION FOR MICRO- AND NANOSPHERES PRODUCTION

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A simple method for turning solid precursors to fine spherical particles would imply vaporization of the material, its condensation to liquid phase droplets and their subsequent quenching. Some of the technically interesting materials would necessitate very high temperatures during the process, which would imply the use of unconventional heating methods. We have addressed the issue by designing an inductively coupled argon plasma torch suited for the thermal treatment of powder precursors.

Microspheres were produced by passing the fine powder precursor material trough the device seen in the Figure. A stream of argon (1) flows through a glass tube and gets ionized in region (8). This ionization is maintained by a continuous feed of energy from the radio frequency generator (4) through coil (5). The plasma has been ignited by a discharge between the electrodes in circuit (3). An additional gas flow (2) winds around the interior tube walls to protect them against overheating. The precursor powder in container (6) is absorbed into dispersing module (7) and carried further by stream (1). Finally the microspheres are collected in a suitable liquid (a surfactant solution) in vessel (9).

The spherical particles fabricated by this method were visualized by optical and transmission electron microscopy. Their size distribution is polidisperse, centered around some tens and hundreds of nm (as seen on TEM photographs) and about microns, a range in which standard light diffraction sizing methods were used.

The materials envisaged were metals (Ni, Fe), oxides (Al_2O_3, ZnO) and glasses. Alumina spheres of various sizes are shown below.