Project 4.10. Mechanoluminescent displays and sensors based on nanostructured piezoelectric materials.

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Webpage of group: http://info.ifpan.edu.pl/Dodatki/WordPress/on41pl/

Background:
The phenomenon of mechanoluminescence (triboluminescence) is known already for about four centuries. Francis Bacon found it while crumbling sugar, Robert Boyle described it for diamond and since then it was observed for many inorganic and organic compounds. However, due to its relatively weak light emission and stochastic nature only recently it became a subject of intensive research, both basic and applied. Mechanoluminescence is the effect of light emission under mechanical stimuli, such as fracture, friction, impact, bending or twisting, which leads to elastic or inelastic deformation of the material. Therefore, depending on the type of generating deformation, mechanoluminescence can be divided into fracto- , plastico and elastico-luminescence. Recently, there is a lot of interest in this phenomenon, as well as in related effects, such as tribochemical reactions or triboelectric generators. In fact, some of the above mentioned effects occur simultaneously.

Aim:
During this project we will synthesize and study selected materials, for which the mechanoluminescence is relatively strong. We will study the mechanisms of this phenomenon, which might be different depending on the type of material, its crystallographic structure, presence of crystal defects, dopants etc. From that point of view the materials doped with rare-earth and transition metal ions exhibiting so called persistent luminescence are very important candidates for our mechanoluminescence experiments. Persistent luminescence is related to existence of so called trap levels in the material, which catch the electrons or holes excited by incoming light. The trapped charges can be next slowly released giving rise to long-lasting luminescence, with very long decay times. The energy necessary for detrapping the electrons and holes from the trap levels depends on the energy (“depth”) of the trap levels in relation to the conduction and the valence bands. Mechanical stress may provide additional energy which can release the charges from the traps. Such free charges may then recombine leading to mechanoluminescence.
Mechanoluminescent composites manufactured from materials with strong triboluminescence and various types of polymer and epoxy foils as well as glasses will be prepared and examined. Finally, the demonstrator of mechanoluminescence sensor will be produced which will serve as the test device for developed theory of mechanoluminescence and show the path for future applications of such materials.
Important part of the project will be related to high-pressure spectroscopy in diamond anvil cells (DAC).
We do plan collaboration with several groups from abroad, including EU, China and others.

Requirements:
- Experience in optical spectroscopy;
- M. Sc. in physics or chemistry;
- Experience in using spectroscopic equipment; programing skills (LabView, etc.)
- sufficient proficiency in English;

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