Description for the general public

The objective of the project is basic research on the formation of nanocrystalline ceramic semiconductors based on nano-ZnO and nano-ATO by direct coagulation casting DCC. DCC method utilizes enzymatic reaction to control coagulation of particles and as a result density of green bodies. Second objective of the project is to use metal salts as additives which are going to be homogenously distributed on the nanopowders surface by controlling the pH using enzymatic reactions. Reduction of grain size influences not only the mechanical properties but also can lead to changes in electric properties of semiconductor materials like ZnO, where current-voltage characteristic is affected by grain boundaries. In technology of ceramic materials the important role play shaping methods which allow to form the product with defined geometry and structure from the powders. The methods based on colloidal processes, including DCC, give the product with complicated geometry, short time of shaping, minimization or elimination of final treatment with expensive tools (mostly based of diamond) and substances harmful for the environments. DCC method, by changing the pH, allows to control the charge on particles surface. In the project this phenomenon will be used to coagulate the nanopowders and modify particles surface by metal ions. As a results the change of electric, optical and thermal properties of sintered material based on investigated powders (ZnO and ATO) will be obtained. The challenge of colloidal process, including DCC, is the use on nanopowders due to their lower concentration in the slurry compared to micropowders.

The research project is based on the development of modern shaping method of nanopowders using enzymes as biocatalysts. In order to realize the objectives of the project the characterization of nanopowders in initial state will be done. Cleaning procedure and deagglomeration of nanopowders will be performed in order to obtain high concentration of solid phase in the slurry. In the next stage, choice of dispersing agent and enzymatic system as well as casting of the slurry into the mould will be carried out. Drying and sintering processes will be conducted based on selected parameters which will minimize cracking of green bodies and grain coarsening in sintered ceramics. Obtained samples will be characterized by microstructure observation and measurements of mechanical and electrical properties.

Gaining the basic and new knowledge concerning production of ceramics with homogeneous and nanometric grain size, specified chemical and phase composition of grain boundaries by DCC method will allow to control electric properties in wide range which is important for electronic industry. It will also bring the possibility of miniaturization of some semiconductor elements which properties are determined by grain boundaries (varistors). This will help in reduction of raw material usage. The knowledge gained within the project concerning effective deflocculation of nanopowders in the slurries or controlling the properties of grain boundaries can be further used for other nanopowders or other shaping methods.