Master/Bachelor Thesis

Mechanochemical conversion of highly luminescent microcrystalline lead-free perovskites into processable nanocrystalline inks for light-emission and photovoltaic applications

Motivation and Topic

Lead-free halide perovskites is one of the most rapidly developing classes of inorganic and organo-inorganic compounds with brilliant perspectives for applications in photovoltaics, LEDs, optical sensorics, etc.

The Chair of Materials for Electronics and Energy Technology (i-MEET) and Helmholtz-Institut Erlangen Nürnberg für Erneuerbare Energien (HI ERN) have recently started collaborative studies of highly luminescent lead-free double halide perovskites, in particular, $Cs_2Ag_xNa_{1-x}Bi_yIn_{1-y}Cl_6$ (CANBIC), which demonstrate photoluminescence (PL) quantum yield (QY) of almost 100%.

A combination of extremely efficient PL emission in the visible spectral range with a very high stability and a strong absorption in UV range makes CANBIC compounds a very promising candidate for applications in photovolotaic light concentrators and light down-shifting materials. These applications, however, require CANBIC perovskites to be converted into transparent and easily processable nanocrystalline "inks", at the same time retaining high stability and ultimate PL QYs of the original microcrystalline CANBICs.

The proposed MSc/BSc project will focus on one of possible approaches – mechanochemical conversion of microcrystals into nanocrystals based on the ball-milling of microcrystalline CANBICs in the presence of colloidal stabilizers and other functional additives.

Tasks (will be reduced in the case of Bachelor-Thesis)

- synthesis of microcrystalline lead-free CANBIC perovskites;
- development of new approaches for ball-milling-based conversion of CANBICs into stabilized nanocrystalline inks including:
  - "wet" ball-milling with additional solvents;
  - ball-milling with supplementary polymer binders;
  - ball-milling with additional coordinative and ionic ligands;
  - ball-milling with additional solids (sources of halide ions, co-milling agents, other semiconductors).
- spectral and physical characterization of microcrystalline/nanocrystalline CANBICs using:
  - absorption, PL, and time-resolved PL spectroscopies;
- Raman spectroscopy;
  - X-ray diffraction, SEM/EDX.

Qualifications

- students in Material Science, Energy Technology, Renewable Energy, Nanotechnology;
- basic chemical knowledge and basic skills in spectral and structural characterization of materials.

The MSc/BSc work will be carried out collaboratively in FAU i-MEET (Martensstr. 7, 91058 Erlangen) and HI ERN (Immerwahrstr. 2, 91058 Erlangen).

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