Project 6.2 Growth of Iron-based superconductors by high-pressure technology and their characterizations

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Background:

The newest family of High Tc Superconductors (HTS) – the iron-based superconductors (FBS) has sparked a lot of interest in basic and practical research. More than 100 compounds are available under this family with numerous novel properties, which provide unique opportunities to understand HTS mechanism. However, one basic challenging problem of this family is the growth of high-quality single crystals and thin films using the Conventional Synthesis Process at ambient pressure (CSP-AP). More details can be found in our latest review article [Crystals 12, 20 (2022) https://www.mdpi.com/2073-4352/12/1/20].

The High-Pressure and High-Temperature growth method (HP-HTS) has several advantages over CSP-AP since it avoids vaporization losses and allows control of the composition (doping) even at the high temperatures required for single crystal growth. This project is designed to grow high-quality single crystals and thin films by HP-HTS. The selected candidate will involve using various growth methods to obtain high-quality single crystals and thin films by HP-HTS and its various characterizations through structural, microstructural, transport, and magnetic measurements to confirm the sample quality and superconducting properties. The student will learn high-pressure techniques, analysis of experimental data, and manuscript preparation for scientific research publications.

Aim:

The goal of this project is to study of parameter optimization for the growth process of the high-quality single crystals and thin films of FBS by using high-pressure techniques and conventional methods, and its basic characterizations (XRD, microstructural analysis, transport measurements, and so on) to confirm the sample quality and the superconducting properties. A series of doped and undoped samples will be grown by the optimized process to draw the synthesis and superconducting phase diagram under the shadow of chemical and applied pressure effects.

Requirements:

- completed studies in the field of physics, chemistry, electronics, materials engineering, or other related subjects that allow you to start working as a doctoral student-scholarship holder,
- readiness to obtain the status of a doctoral student in physics,
- crystal growth and thin film fabrication processing skills, as well as experience with high-pressure research, will be advantageous,
- experience with glove boxes, quartz tube sealing, and cleanrooms will be advantageous,
- research experience in physical and magnetic measurements will be an additional benefit,
- knowledge of English that allows for the comprehension of professional literature in a given discipline, as well as the presenting of results, discussion, and research paper writing,
- ability and passion for scientific research works,
- good knowledge of fundamental solid-state physics especially superconducting and magnetic materials,

- experience to work with low-temperature high magnetic field facilities and Labview Program will be beneficial,
- readiness to work in the high-pressure Laboratory at the IHPP PAS.