Project 6.3 Critical current density and flux pinning behavior of Iron-based superconductors by high-pressure technology

Supervisor: Professor Dr. Andrzej Wisniewski (Institute of Physics, PAS) / Dr. Shiv J. Singh (IHPP PAS)
Institute: Institute of High Pressure Physics PAS
Unit: Laboratory of Superconductors (NL-6))
www: www.unipress.waw.pl

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 temperature 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 focus on various characterizations of the high-quality samples through transport, thermal and magnetic measurements to analyze the superconducting properties, especially the pinning mechanism and critical current density. He/she will be able to spend time in laboratories utilizing high-pressure techniques and will become an expert in various types of characterizations employing high magnetic field facilities and data processing for basic and practical research

Aim:

The goal of this project is to use unique and unusual high-pressure growth techniques to investigate the inherent vortex pinning behaviors of HTS through a comprehensive investigation of various FBS and its application to understanding the critical current (Jc) attributes and anisotropic nature. The flux pinning force density and the pinning parameters will be analyzed in more detail to understand the pinning mechanisms. Based on our transport and magnetic studies, superconducting and vortex phase diagrams will be drawn for stoichiometric and doped families of FBS to explore the intrinsic critical current properties of FBS.

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,
- good knowledge of fundamental solid-state physics, especially properties of superconducting and magnetic materials,
- readiness to work in the high-pressure Laboratory at the IHPP PAS,
- experience to work with low-temperature high magnetic field facilities and Labview program will be beneficial,
- physical and magnetic measurements research experience will be advantageous,
- experience with high-pressure technology will be an additional benefit,

- knowledge of English that enables understanding of professional literature in a given field, as well as presentation of results and discussion and writing research paper,
- ability and passion for scientific research works.