Ministry of Human Resources and Social Security

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

2019 Helmholtz – OCPC – Program

for the involvement of postdocs in bilateral collaboration projects

PART A

Title of the project:
Advanced self-passivating materials for an application in extreme environment of future renewable energy systems

Helmholtz Centre and institute:
Forschungszentrum Jülich, Institute of Energy and Climate Research, Plasma Physics (IEK-4)

Project leader: Dr. Andrey Litnovsky

Web-address: http://www.fz-juelich.de/iek/iek-4/EN/Home/home_node.html

Description of the project:
Refractive materials, such as tungsten (W) and molybdenum (Mo) have a number of decisive advantages, which make them attractive candidates for use in the prospective renewable energy systems. A high melting point, high thermal conductivity at elevated temperatures and low retention of radioactive elements, make refractive materials extremely favorable for e.g. future fusion power plants where these materials can be used for the first wall cladding or for concentrated solar power plants, where a high temperature material is needed for a solar receiver. At the same time, the oxidation of refractive metals at temperatures of about 1000^{o}C represents an essential obstacle for their implementation in energy systems. Besides the degraded mechanical properties due to corrosion, vaporization of neutron-activated tungsten oxide at temperatures above 1000^{o}C imposes a safety hazard for e.g. fusion power plant.
The self-passivating advanced alloys are under development to address this issue. In self-passivating systems, the oxidation is suppressed by dedicated alloying elements. Alloying elements form their own dense oxides, protecting refractive metals from oxidation.
Investigations of fundamental processes occurring in the alloys comprise among others, studies the diffusion of oxygen and alloying elements, the formation and growth of oxide scale and a phase stability at various temperatures. Studies of self-passivating action of alloy systems will be a part of the post-doctoral activity.
The self-passivating alloy systems containing tungsten (W), chromium (Cr) and yttrium (Y) were produced via mechanical alloying and densified using field-assisted sintering technology (FAST). Created bulk W-Cr-Y alloys have already demonstrated 10^{5}-fold suppression of oxidation under atmospheric conditions at the temperature of 1000^{o}C in comparison to that of pure tungsten. Newest studies demonstrated advantages of using zirconium (Zr) as an active element in self-passivating alloys. These studies however, were performed on thin film laboratory samples and the production of bulk W-Cr-Zr smart alloys is a necessary step for assessing the potential of new alloys. This study will be another responsibility of a prospective post-doctoral fellow.

Another important topic is an upscaling of the bulk self-passivating alloys to sizes, suitable for the relevant energy systems. For a fusion power plant, it would mean a production of dense self-passivating alloy with sizes of at least 4.0×4.0×0.2 cm joined with stainless steel body forming a "flat-tile" monoblock. For a solar receiver, the upscaling would mean a production of porous receiver cell with dimensions of at least 1.0×1.0×1.0 cm. The upscaling and testing of the produced components will be a responsibility of a post-doctoral fellow.

Description of existing or sought Chinese collaboration partner institute:
Hefei University of Technology (HFUT) has a strong standing in China as one of the leading centers of material research. The university possess a decades of experience in fundamental material research and in innovative production techniques. Our institute IEK 4 at FZJ has an established collaboration program with HFUT. Joint studies on advanced materials and specifically, on self-passivating alloys are underway bring already excellent results in manufacturing of W-Cr-Y systems and in exploring the newest W-Cr-Zr alloys. Apart of high potential for joint investigations, the HFUT possesses a variety of state-of-the-art equipment. The FAST facility, located at the School of Materials Science & Engineering of HFUT is already available for industrial upscaling of bulk alloy systems, synergistically contributing to the proposed project. There are numerous application fields where IEK 4 FZJ and HFUT can further intensify collaboration. Among them are the advanced mechanical alloying of new materials e.g. in the Key Laboratory for Powder Metallurgy at HFUT and in PowderLab at IEK 4 FZJ, thermo-mechanical tests and studies under accidental conditions in both partner institutions. A proposed post-doctoral project is aiming at further intensifying a mutually beneficial collaboration program between IEK 4 FZJ and HFUT.

Required qualification of the post-doc:
- PhD degree in material science or mechanical engineering before the end of 2019.
- Experience with mechanical alloying and in FAST manufacturing.
- International experience of the candidate (e.g. in Germany) is preferred.
- The candidate shall be communicative and be able to work in a team.

PART B

Documents to be provided by the post-doc, necessary for an application to OCPC via a postdoc-station in China, which is affiliated to a research institution like a university:

- Detailed description of the interest in joining the project (motivation letter)
- Curriculum vitae, copies of degrees
- List of publications
- 2 letters of recommendation
- Proof of command of English language

PART C

Additional requirements to be fulfilled by the post-doc:
- Max. age of 35 years
- PhD degree not older than 5 years
- Very good command in English