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:
Development of large-scale tungsten fiber-reinforced tungsten composites (W_f/W)

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

Project leader: Dr. Jan W. Coenen

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

Description of the project:

For the first wall of a fusion reactor, unique challenges on materials in extreme environments require advanced mechanical and thermal properties. Tungsten (W) is the main candidate material for the plasma facing material of a fusion reactor as it is resilient against erosion, has the highest melting point of any metal and shows rather benign behavior under neutron irradiation. However, the intrinsic brittleness of tungsten is a concern under high transient heat loads. Additionally, neutron induced effects e.g. transmutation add to embrittlement and are crucial to material performance.
To overcome brittleness of W, tungsten fiber reinforced tungsten (W_f/W) composites have been developed relying on an extrinsic toughing principle. Two production routes have been established to obtain the W_f/W bulk material, accordingly, Chemical Vapor Deposition (CVD) route and Powder Metallurgy (PM) route. In previous study, it has been proven that the extrinsic toughening principle can be realized by the as-produced products. In cooperation with a weak oxide interface and high strength tungsten fibers, a so-called pseudo-ductile fracture behavior can be achieved instead of a brittle fracture.
For the next step, in this project, production of large-scale W_f/W composites, and in particular characterization (e.g. mechanical tests, mock-ups exposure) of the produced materials in standard scale are the main focuses of this project.
Regarding the PM production route, Spark Plasma Sintering (SPS) is the main process involved. Large-scale SPS facility is of great help to this research. Samples with up to 300 mm in diameter will be sintered in one batch to meet the requirement of the standard tests and the mock-up manufacturing. Currently, the fiber-matrix interface production limits the production rate of the material. This issue can be solved potentially via two possibilities: either a more efficient interface production process should be performed (e.g. sol-gel process), or a porous-matrix composite concept should be used to avoid the interface.
About the CVD route, currently, the layer deposition process need to be updated. Continuous deposition process is the target direction to realize the high production rate.

Also, the optimization of the fiber volume fraction and porosity will be conducted based on the theoretical simulation work.
In parallel, the postdoc will assist the project leader to supervise students in the group, involving the production and characterization techniques related to W-based components.
In the end of the project, the expected output would be that, a standard process of both PM and CVD processes can be established to produce large-scale W_f/W. The important mechanical and physical properties of the products should be characterized based on the standard tests.

Description of existing or sought Chinese collaboration partner institute:

School of Materials Science & Engineering in Hefei University of Technology (HFUT) has a history of more than 5 decades and has deep traditions and advantages in researching advanced materials. HFUT has the advantages of equipment and experience in powder metallurgy process and material microstructure characterization. The school is equipped with various professional research centers including a Key Laboratory for Powder Metallurgy. In the past years, the cooperation between the HFUT and IEK-4 is getting closer. The two sides have full cooperation in the field of experimental applications. The two institutes often have exchange programs for students and scholars. In addition, the two sides often conduct academic workshops. We hope this OCPC post-doc program will promote a more intensive collaboration in terms of advanced materials.

Required qualification of the post-doc:

- The candidate needs to have a PhD degree in material science or mechanical engineering before the end of 2019.
- Experience with composite material development and powder metallurgy processes; experience with tungsten material development is of advantage.
- Preferred is also international experience of the candidate (e.g. in Germany).
- The candidate shall be communicative and 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 of the English language
- Strong ability to work independently and in a team