2016 Jülich – OCPC – Programme

for the involvement of postdocs in bilateral collaboration projects

PART A

Title of the project: Quantum transport in nanostructured topological insulators

Jülich's institute: Peter Grünberg Institute 9 - Semiconductor Nanoelectronics

Project leader: Prof. Dr. Thomas Schäpers

Web-address: http://www.fz-juelich.de/pgi/pgi-9/DE/Home/home_node.html

Description of the project (max. 1 page)[1]**:** see overleaf

Description of existing or sought Chinese collaboration partner institute (max. half page)**:**
The post-doc project is part of our research activities within the Virtual Institute for Topological Insulators (VITI). The virtual institute is formed by research groups at RWTH Aachen University, Würzburg University and Forschungszentrum Jülich. Furthermore, as an international partner the Shanghai Institute for Microsystem and Information Technology (SIMIT), member of CAS, is member of VITI. As mentioned in the detailed project description the goal of the virtual institute is to conduct research on topological insulators towards future spinelectronic and quantum information processing devices. In the past years VITI initiated a number of international collaborations, i.e. with the University of Southern California or the Russian Academy of Sciences in Chernogolovka, in order to broaden the material basis or to include characterization methods not being provided by the VITI partners. It is very well known in our research community, that at Chinese universities as well as at the Chinese Academy of Sciences, very competetive research on topological insulators is pursued. Therefore, we are very interested to establish new collaborations with partners in China or to further strengthen or ties with our partner at SIMIT. The envisioned post-doc projects would put us in the position to start a research activity with new partners, which will hopefully be extended in the future. The benefit for the Chinese partner would be to be integrated in a well-established and very lively research environment provided by VITI.

Required qualification of the post-doc:

- PhD in physics or electrical engineering
- Experience with cleanroom preparation, e.g. optical and/or electron beam lithography, wet and dry etching or evaporation. Furthermore, experience in transport experiments at low temperatures is advantageous.
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[1] Please add overleaf

- Additional skills in computer aided design (CAD) would be advantageous, but not mandatory.

PART B

Documents to be provided by the post-doc:

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

PART C

Additional requirements to be fulfilled by the post-doc:

- Max. age of 33 years
- PhD degree not older than 5 years
- Very good command of the English language
- Strong ability to work independently and in a team

Description of the project:

Within the envisioned project electrical transport measurements shall be conducted on nanostructures based on topological insulators (TI). Topological insulators are a new state of matter, where the surface is conductive whereas the bulk is insulating. Compared to other materials with conductive surface states, these states are topologically protected, i.e. they cannot be removed by outer distortions. Since a few years the Peter Grünberg Institute 9 (PGI-9) conducts research on this novel material class. The reseach projects include the epitaxial growth of topological insulators, the nanostructuring in the Helmholtz-Nanoelectronic-Facility (HNF), and quantum transport investigations. The activities at PGI-9 are an integral part of the research performed within Virtual Institute for Topological Insulators (VITI). Within VITI research groups at RWTH Aachen University, Würzburg University, Shanghai Institute of Microsystem and Information Technology (SIMIT), and Research Centre Jülich joined forces to establish the fabrication of high quality topological insulators, which might be integrated in future high performance spinelectronic devices or in circuits utilizing topological quantum computation. The post-doc candidate shall conduct research on nanostructured topological insulators. The aim of the research project is to find new routes for utilizing topological insulator nanostructures for device applications. By using nanostructured topological insulators where the phase-coherence length is smaller than the sample dimensions interference effects can be utilized for novel device functionalities. Furthermore, by employing superconducting electrodes, circuit concepts towards topological quantum computation can be assessed. The topological insulator layers grown by molecular beam epitaxy are

provided from the TI growth group at PGI-9. Regarding the epitaxial layers, mainly heterosystems, which were recently designed in Jülich, will be used. The nanostructure geometry will be directly defined by selective area growth. Subsequently, ohmic contacts as well as gate electrodes will be prepared. For a subset of samples superconducting electrodes will also be employed. The candidate will have the chance to utilize the Helmholtz Nanoelectronic Facility for sample preparation. The transport experiments will be performed at the PGI-9 low temperature lab. Here, all equipment required to perform sensitive transport experiments is provided. From the transport experiments, information on the phase-coherent transport will be gained. As an example Aharonov-Bohm type conductance oscillations will be investigated, which is one of the interference effects, suitable for electron interference-based devices. For the nanopatterned structures equipped with superconducting electrodes, Andreev reflection and the Josephson supercurrent will be analysed.