Helmholtz–OCPC Programme 2017-2021
for the Involvement of Postdocs in Bilateral Collaboration Projects with China

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Office of the China Postdoctoral Council (OCPC)
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(MoHRSS)

Part A

Title: Mobility of charge carriers in self assembled monolayers

Name of KIT Institute:
Institute of Functional Interfaces

Name and Contact Information of the KIT project leader:
Prof. Dr. Christof Wöll
Institute of Functional Interfaces
Karlsruhe Institute of Technology
76344 Eggenstein-Leopoldshafen
Germany

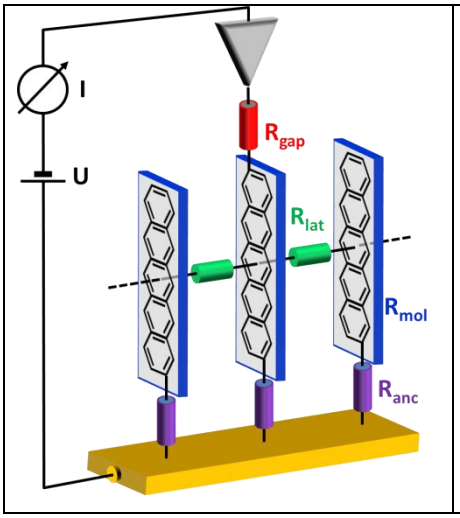
Phone: +49-721-608-2-3934
Fax: +49-721-608-2-3478
Email: christof.woell@kit.edu

Internet address:
http://www.ifg.kit.edu/english/index.php
http://www.ifg.kit.edu/english/103.php

Description of the Scientific Topic:

For electronic devices based on organic semiconductors (OSCs) the basic understanding of the charge transport mechanism in the OSCs is of great importance. The experimental determination of the intra- as well as the intermolecular charge carrier mobility as a function of the molecular structure is still extremely challenging, but a must not only to validate theoretical results but also to develop strategies, which aim (i) at the optimization of the OSC properties for a specific application and (ii) at the tailored inclusion of the OCSs into a technical environment of a device by the chemical tuning of the semiconducting molecules. One requirement for a significant progress in that direction is the provision of reliable experimental results for the charge carrier mobility measured at structurally well-defined systems such as OSC-based, highly oriented self-assembled monolayers (SAMs).

Within the project a new method will be developed which enables the determination of the charge carrier mobility within N-heterocyclic OSC SAMs not only vertical ($R_{gap}+R_{mol}+R_{anc}$ in Fig. 1) but also parallel to the supporting substrate (R_{lat} in Fig. 1) by using conductive probe microscopy based on atomic force microscope (AFM) technique (Fig. 1). The conductivity will be determined as a function (i) of the lateral size and shape of the two-dimensional highly oriented SAM structures (islands) which will be prepared by the AFM-based nanografting method (Fig. 2) and (ii) of the chemical structure of the OSC molecules. The required N-heterocyclic OSC molecules will be synthesized by cooperating organic chemists, who will create SAM molecules with anchor groups for the chemical boding to the substrate and with different side groups, which will influence the charge transport. Finally the results of the experimental determination of charge carrier mobility will be compared with theoretically calculated values.



R_{gap} = Tip-molecule resistance
R_{mol} = Resistance of the molecule
R_{lat} = Resistance over the area
R_{anc} = Anchor-substrate resistance

Fig. 1 Scheme of the conductive AFM based determination of charge carrier mobility in SAMs consisting of organic molecules with lateral charge mobility.

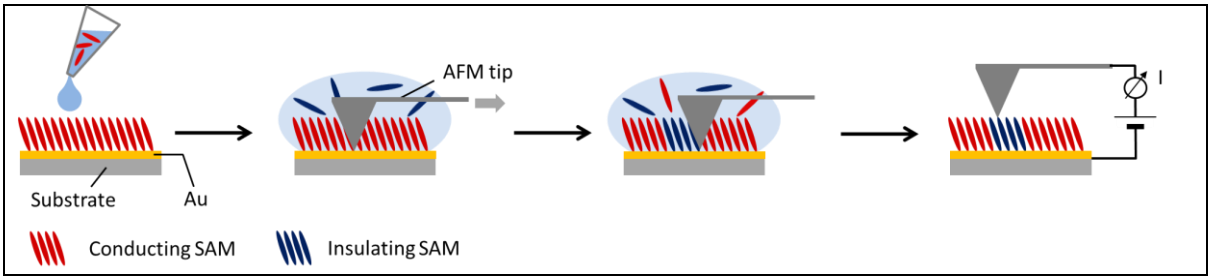


Fig. 2 Scheme of the AFM-based nanografting technique to “write” islands of conductive SAMs into a matrix of insulating SAMs.

Description of the existing or planned collaboration with a Chinese institution
The Institute of Functional Interfaces (IFG) had built academic cooperation with the Fujian Institute of Research on the Structure of Matter (FJIRSM), Chinese Academy of Sciences (CAS) from 2015. Actual cooperation are focused on chiral porous meta-crystals, liquid-phase epitaxy to assemble metal-organic framework film and the related applications. Until now, three good articles have been published in the journals, respectively (*Appl Phys Lett*. **2015**, *107*, 183301-183305, *ACS Nano* **2016**, *10*, 977-983, *Inorg. Chem.* **2017,** in press.). In 2015, Prof. Dr. Christof Wöll had visited FJIRSM, CAS for academic exchange.

The next steps will be to encourage young scientists from China to engage in this opportunity on collaborative research. The German and Chinese partner institutes will share research and best practices with each other, and will pursue specific goals such as the development of surface science and technology. Academic and collaborative opportunities for students and faculties across both institutes will be encouraged, including the synthesis of the organic molecules, characteristics of the structure and theoretic calculation.

Qualifications of the Applicant required:
Candidates should hold a Master and PhD in physics or chemistry and possess research experience in the fields of chemical surface functionalization and surface characterization (XPS, ToF-SIMS, IR and Raman spectroscop, XPS), AFM technology, SAMs and knowledge in the field of molecular electronics.

Part B of the form contains the documents to be submitted by the postdoc to the OCPC and can be supplemented and modified by the project leader depending on the project proposal.

- Reason for the candidate's personal interest in a research visit to KIT
- CV and copies of certificates
- List of publications
- Two letters of recommendation
- Evidence of competence in English

Part C of the form describes the conditions of the programme which must be observed by the postdoc.

- Completion of PhD within the past five years
- Not older than 35 years at the time of application