Helmholtz - OCPC - Programme 2017-2021

for the Involvement of Postdocs in Bilateral Collaboration Projects with China

PART A

Title of the project

Design, synthesis and evaluation of synthetic chemosensors for analyte detection in aqueous media

Helmholtz Centre and institute

Karlsruhe Institute of Technology (KIT), Institute of Nanotechnology (INT)

Project leader

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Description of the project:

The recognition and detection of environmentally and biologically important analytes is of prime importance and has become an upsurging area of research in both chemistry and biology in the recent years. Since the recognition events occur on a molecular level, the gathering and processing of information poses a fundamental challenge. The development of robust chemical molecular sensors ("chemosensors") with the potential to detect molecules selectively and signal their presence continues to attract considerable attention for example, optical chemosensors suitable for practical measurement of sodium in serum and whole blood samples has been reported, which is essential in clinical diagnosis and as markers for diseases.

The monitoring and detection of small and medium sized molecules such as toxins, (*e.g.* pesticides, herbicides, PACs etc.), drugs, neurotransmitters, and hormones in aqueous and biological media has become of vital importance, particularly in environmental analytics (e.g. pollution monitoring of drinking and waste water) and is of great interest for medical diagnoses and fundamental biological and medical research. Chemosensors would offer here a cost-efficient alternative over contemporary HPLC-MS methods and would uniquely offer label-free *in situ* and real-time monitoring capabilities. Likewise, chemosensors for structurally more complex (bio)organic analytes would be of great practical utility. However, the low binding affinity of artificial chemosensors for most organic species is the main reasons why the practical application potential of artificial chemosensors has not yet been fully realized.

Artificial chemosensors can be synthesized from chemically robust components and the binding site can consist of a cavity or cleft enforced by stable covalent bonds. Their molecular architectures are limited only by the creativity and capabilities of synthetic organic chemists. In principle, artificial chemosensors can be tailored for a broad variety of analytes. Their optical properties, solubilities and other characteristics can be adjusted to meet requisite sensor specifications.

Analyte affinity is a matter of primary importance in chemosensor design. Most organic analytes of biological interest, *e.g.*, amino acids, peptides, neurotransmitters, hormones, drugs and toxins, naturally occur typically in a mM to nM concentration range in an aqueous media. Thus, chemosensors with affinities (K_a) of $>>10^3$ M^{-1} (*i.e.*, $K_d << 10^{-3}$ M) are commonly preferred. However, most of the known artificial chemosensors exhibit too low binding affinity in water, in particular for non-charged analytes, which is a major challenge to overcome. In our line of research, this will be overcome by utilizing concave, hydrophobic hosts containing "high-energy cavity water", such as cucurbit[*n*]uril macrocycles, which are record-high high-affinity binders, as the sensor scaffold. The main objectives of the research project that should be carried out by the postdoctoral candidate are:

- The development and preparation of an innovative, functional chemosensor for a range of environmentally and biologically relevant organic analytes (functionality)

- The development of a sensitive analyte specific signal transduction pathway using self-assembled supramolecular chemosensors (analyte differentiation through spectroscopic fingerprints)
- Ensure chemical stability of the developed chemosensor in both aqueous solution and biological media (stability)
- Prove of principle studies for "real world sensing applications" such as analyte detection in biological media, medical diagnosis, bioimaging etc. (application).

Description of existing or sought Chinese collaboration partner institute:

We currently collaborate with the group of Wei Jiang (Southern University of Science and Technology) on supramolecular chemosensing ensembles. We also have joined work with the group of Dong-Sheng Guo (Nankai University) on the development of supramolecular permeation assays.

Required qualification of the post-doc:

- PhD in Chemistry
- Experience with synthesis of macrocyclic hosts and characterization of their host-guest complexes by standard supramolecular and photophysical characterization.
- Additional skills in analytical method development and programming (e.g. with Mathematica or MatLab) are desirable. The postdoctoral candidate should be able to interact and guide PhD students, therefore fluent English is required.

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

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