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

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Project Title: Shape Memory Nanoactuators for Nanophotonic Devices

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Institute of Microstructure Technology (IMT)
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Part A

Project Proposal:

This research focuses on novel integrated actuators based on shape memory alloys (SMAs) with nanoscale dimensions for control of optical signals in silicon waveguide structures.

Miniaturization and integration of SMA actuators in nanoscale systems is motivated by their large work output in the order of 10^7 Jm^{-3} enabling ultra-small layouts. One example is the ferromagnetic SMA NiMnGa that exhibits outstanding actuation properties in bulk shape, such as thermo-elastic and magneto-strain effects up to 12%. Using these effects at the nanoscale opens up a new generation of mechanically active devices having switching and tuning capability. Here, target applications are adaptive silicon photonic devices that are expected to provide substantial size and cost reduction compared to traditional optical solutions in communication technology. In previous work, free-standing SMA-Si bimorph cantilever actuators with lateral dimensions of 200 nm have been developed showing actuation based on superimposed shape memory and bimorph effects. This technology will be further down-scaled to lateral dimensions below 100 nm and combined with Si waveguide technology. The thermo-mechanical and optical

properties of mechanically active Si photonic devices will be investigated by finite element (FE) simulations and in-situ measurements.

The research topic includes the following tasks:

- Characterization of SMA material properties (SEM, XRD, DSC, tensile experiments, DIC...)
- Development / optimization of nanofabrication technologies
- Finite element simulations (multiphysics), modeling of optical wave propagation
- Design, fabrication and characterization of Si photonic demonstrator systems

This research has a pronounced interdisciplinary character covering different fields of materials science, mechanical and electronic engineering. For fabrication, the IMT operates a state-of-the-art cleanroom facility including electron beam lithography, physical vapor deposition and reactive ion etching. Furthermore, IMT is part of the Karlsruhe Nano Micro Facility (KNMF) at KIT providing free access to multi-material state-of-the-art micro and nanotechnologies. Advanced simulation tools and measurement equipment are available for investigation of device performance.

Cooperation:

IMT is seeking for new collaboration(s) with one or several research groups at China's top elite universities at the interface of smart materials research, nanotechnology and photonics. The demanding and interdisciplinary nature of the research topic requires expertise from the fields of materials science, physics and engineering. The postdoctoral candidate(s) will be integrated into a running project at IMT in order to establish an international collaboration of researchers with complementary expertise and common interest in translating basic science and new technology into photonics applications.

Requested qualification:
Background in materials science, mechanical and electrical engineering, cleanroom technologies; experience in FEM simulation is of advantage

Part B

- 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
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Part C

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