2025 Helmholtz – OCPC – Programme

for the involvement of postdocs in bilateral collaboration projects

PART A

Title of the project:

Sustainable radiative cooling technologies for buildings and greenhouses

Helmholtz Centre and/or institute:

Karlsruhe Institute of Technology (KIT), Institute for Microstructure Technology (IMT)

Project leader:

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Description of the project (max. 1 page)**:**

Cooling human-made structures, such as buildings and greenhouses, is an urgent global challenge. Conventional cooling systems, such as air conditioners, are energy-intensive, rely on electricity, and often use refrigerants with harmful environmental effects. With cooling energy demand projected to more than triple by 2050, there is a critical need to develop sustainable cooling technologies that can reduce energy consumption and associated emissions.

Passive daytime radiative cooling (PDRC) has emerged as a promising solution by leveraging the cold universe (~3 K) as an infinite heat sink. PDRC materials selectively emit thermal radiation through the long-wave infrared (LWIR) atmospheric transmission window (~8–13 μm) while minimizing solar absorption (~0.3–2.5 μm) to passively dissipate heat. This technology holds immense potential for reducing cooling loads without external energy input.

Despite rapid advancements in PDRC, key challenges remain in achieving the optimal combination of high cooling performance, scalability, durability, and cost-effectiveness. Moreover, existing PDRC materials primarily function by reflecting most incoming sunlight, limiting their use in applications requiring transparency, such as vehicle windows, greenhouses, or hybrid integration with solar harvesting systems. Addressing these challenges necessitates breakthroughs in material design and a shift from material-level studies to device- and system-level implementations for real-world applications.

This project aims to develop next-generation PDRC materials and devices, incorporating micro- and nano-photonic structures to achieve multifunctionality, including selectively high emissivity, self-cleaning properties, and tunable transparency or reflectivity. Special emphasis will be placed on emerging ceramic-based radiative cooling materials, which offer robust performance in outdoor environments, as well as switchable radiative cooling materials and radiative cooling materials for water harvesting etc. The project will further push the boundaries by upscaling the materials, demonstrating integrated PDRC devices and systems, employing materials for applications in buildings and greenhouses.

By bridging multiple disciplines—materials science, heat transfer, thermodynamics, solar engineering, and mechanical engineering—this project will drive advancements in sustainable cooling technologies, paving the way for clean solutions.

We encourage candidates with an interest in this cutting-edge research to apply. Prior experience in this specific research area is not required.

Description of existing or sought Chinese collaboration partner institute (max. half page)**:**

This project is open to all Chinese universities and institutions. We look forward to collaborating with Chinese partners who share our goal of advancing this ambitious research project for a sustainable future. There is currently no existing or sought Chinese collaboration partner institute assigned to this project.

Required qualification of the postdoc:

<Sample text below>

- PhD in Engineering Thermophysics, Thermal Engineering, Mechanical Engineering, Material Engineering, Electrical Engineering, or Chemical Engineering.
- Fluent in English speaking and writing.