2026 Helmholtz – OCPC – Programme

for the involvement of postdocs in bilateral collaboration projects

PART A

Title of the project:

Understanding and Controlling Interfaces in Sulfide Solid Electrolytes

Helmholtz Centre and/or institute:

Forschungszentrum Jülich

Project leader:

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Department: (at the Helmholtz centre or Institute)

Institute of Energy Technologies - Fundamental Electrochemistry (IET-1)

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

All-solid-state lithium batteries are widely regarded as a key technology for safer and higher-energy electrochemical storage. Among solid electrolyte families, sulfide solid electrolytes are distinguished by their high ionic conductivity and favorable processability. Despite rapid progress in materials development, the practical realization of robust solid-state cells remains limited by coupled interfacial and stability challenges. In particular, sulfide electrolytes are highly sensitive to ambient exposure, and their solid–solid interfaces with lithium metal anodes and high-voltage cathodes can undergo complex chemo-electro-mechanical evolution. These interfacial processes often manifest as impedance growth, loss of effective contact, non-uniform current distribution, and in severe cases, lithium dendrite penetration. A deeper understanding of how interfacial chemistry and mechanics jointly govern macroscopic cell behavior is, therefore, essential for designing solid electrolytes that are not only high-performing under ideal conditions but also reliable in realistic processing and operational environments.

In this project, we will investigate how sulfide electrolyte surfaces and interfaces respond to key external cues, such as environmental exposure, mechanical pressure, and electrochemical driving forces, and how these cues reshape the interphase formation and ionic transport pathways. Inspired by the concept that interfacial functionality can be engineered through nanoscale control of surface chemistry, we aim to develop surface-modification strategies that simultaneously improve environmental tolerance and interfacial compatibility without sacrificing fast Li^+ conduction. Central to this effort is to reveal how subtle changes at the nanometer scale propagate across length scales: from particle surfaces to interparticle contacts, from local heterogeneity to global current distribution, and ultimately to cell-level stability and lifetime.

Mechanistically, we are interested in how interfacial signals, chemical potential gradients, space-charge effects, and stress accumulation are coupled and transduced into measurable electrochemical outcomes. By combining controlled materials processing with interface-sensitive characterization and electrochemical analysis, the project will establish a coherent framework linking surface/interface design to failure-mode transitions and performance limits. The resulting insights will support the rational design of interface-compatible sulfide electrolyte systems and provide broadly applicable principles for engineering robust solid–solid interfaces in next-generation solid-state batteries.

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

The project will be supported by established collaborations with two complementary Chinese partner institutes: the China Spallation Neutron Source and Nanchang University.

CSNS provides world-class large-scale neutron-scattering capabilities that enable non-destructive, bulk-sensitive probing of structure and dynamics. Neutron-based methods are uniquely valuable for studying light elements (including lithium) and for accessing information that is difficult to obtain with conventional laboratory techniques, particularly under realistic environments. Through our existing collaboration, CSNS offers access to advanced beamlines and scientific support for experiments aimed at resolving structure–transport–stability relationships in complex energy materials and interfaces. Nanchang University contributes strong expertise in materials chemistry and electrochemistry, with capabilities spanning synthesis and processing of functional materials, interfacial engineering, and systematic electrochemical evaluation.

Required qualification of the postdoc:

- PhD in PhD in Materials Science, Chemistry, Chemical Engineering, Physics, or a closely related discipline, with demonstrated research experience in electrochemical energy materials.
- Experience with solid-state battery materials and electrochemical characterization, ideally including one or more of the following: solid electrolytes (especially sulfide-based), electrode-electrolyte interfaces, impedance spectroscopy (EIS), galvanostatic cycling, and solid-state cell assembly/handling under inert atmosphere.
- Additional skills in thin-film or surface engineering and deposition technologies, such as atomic layer deposition (ALD) and/or chemical vapor deposition (CVD) (including precursor handling, process optimization, and coating/film characterization). Experience in related vacuum/thermal processing and surface/interface characterization (e.g., XPS, SEM/EDS, XRD, Raman/FTIR) is an advantage. Familiarity with data analysis for correlating processing-structure-property relationships is preferred.
- Language requirement: fluency in English (written and spoken). German is not required but desired; willingness to collaborate in an international and interdisciplinary team is expected.