Journey into Energy Materials Research Through In Situ Operando Techniques

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ABSTRACT

Nowadays, the increasing demand for sustainable energy is driving advances in the field of energy materials, particularly processed materials that can convert waste into fuels or high-value products, and batteries for energy storage. These materials are fundamental to developing high-performance and sustainable systems for addressing the trends of energy demands. My background is in materials science and engineering, studying the synthesis and characterization of materials, as well as the response to change. I am focusing on energy materials in both conversion materials and battery systems.

By the way, both high-performance batteries and conversion materials, as follows, certain types of Li electrodes, and CO_2 reduction reaction (CO_2RR) systems, undergo complex structural transformations during cycling, including phase changes, particle transportation, and the formation of reaction intermediates. These dynamic processes are critical to the performance of energy devices but are challenging to study using traditional ex situ techniques, which observe only the beginning or final states of a material after it has undergone a reaction. Therefore, in situ operando techniques allow researchers to observe materials in real time under operating conditions also indispensable. Combining these types of characterizing techniques would provide an understanding of insight into the reaction mechanisms at the atomic and molecular level. The obtained information is crucial for improving material design for better performance.

I am particularly interested in joining Prof. Wu's research group because of the group's expertise in in situ characterization (FTIR, XAS, SEIRAS, etc.) [1],[2],[3] and high-performance ex situ characterization (XRD, XPS, XAS). [4],[5] They're innovative approach to linking fundamental mechanisms with practical applications in energy materials. Prof. Wu's research represents a unique opportunity to further develop my skills in advanced techniques and to contribute to performing projects that improve the performance of energy materials. I am eager to collaborate with the team that is at the forefront of this exciting field and to further explore the potential of in situ methods for advancing energy materials research.

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