Emerging societal challenges, such as the need for more sustainable energy and catalysis, drive the design of novel materials, and subsequently the need for more sensitive multi-functional nanoscale characterization tools. Hence, the ability to advance spectroscopy with nanoscale spatial resolution holds great promise to meet the demands of a deeper understanding of nanomaterials for real applications.

In this work, the impact of nanoscale characterization on energy-related and catalytic materials is considered. We first discuss how revealing nanoscale properties of solar cell active layers and supercapacitor electrodes can greatly benefit the performance of devices. Next, we focus on two dimensional materials as promising alternative catalysts to replace conventional noble metals for carbon sequestration and its conversion to added-value products. Defect-laden hexagonal boron nitride (h-BN) has been identified as a good catalyst candidate for carbon sequestration. Theoretically, defects exhibit favorable properties as reaction sites. However, the detailed mechanism pathways cannot be readily probed experimentally, due to the lack of tools with sufficient sensitivity and time resolution.

A comprehensive study of the design and material processes used to introduce defects in h-BN in view of improving the catalytic properties is presented. The processing-structure-property relationships are investigated using a combination of conventional characterization and advanced nanoscale techniques. In addition to identifying favorable conditions for defect creation, we also report on the first signs of local reactions at defect sites obtained with nanoscale spectroscopy. Next, we explore avenues to improve the sensitivity and time-resolution of nanoscale measurements using light-assisted AFM-based nanomechanical spectroscopy. For each configuration, we evaluate the new system by comparing its performance to the commercial capabilities.

Lastly, we provide a perspective on the opportunities for state-of-the-art characterization to impact the fields of catalysis and sustainable energy, as well as the urge for highly sensitive functional capabilities and time-resolution for nanoscale studies.

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The public is welcome to attend.