

ABSTRACT

In situ Bragg Coherent Diffraction Imaging and Nano-Diffraction from Energy Materials

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The emergence of 4th generation x-ray light sources offers an unparalleled opportunity for conducting in situ and operando studies of nanoparticle structures in complex environments, especially in the field of energy materials. Gaining insights into the dynamic strain behavior of catalysts is critical for developing cost-effective, efficient, and long-lasting catalytic systems. In this talk, I will demonstrate how Bragg coherent x-ray imaging (BCDI) [1] enables three-dimensional (3D) nanoscale imaging of strain, defect dynamics, and re-faceting processes within nanoparticles during catalytic reactions. For instance, we successfully mapped the 3D lattice displacements and strain distribution of a platinum nanoparticle under electrochemical conditions [2] and during CO oxidation [3,4]. More recently, we achieved sub-second time resolution during operando chemical reactions, detecting oscillatory strain changes with a 6.4-second periodicity, directly associated with site-specific CO adsorption during oxidation [5], with a benchmark resolution of 0.25 seconds. Additionally, I will present our latest findings on the core-shell transition in NiFe catalysts during annealing [6], discuss the potential of measuring particles as small as 20 nm [7] and demonstrate high-energy imaging of embedded materials [8] using BCDI. Finally, I will highlight how operando scanning nano-diffraction can reveal the evolution of strain and defects in nanocrystals during battery charge-discharge cycles [9,10].

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