Probing The Atomically Diffuse Interfaces in Core-Shell Nanoparticles In Three Dimensions

Zezhou Li[1], Zhiheng Xie[1], Yao Zhang[1], Xilong Mu[1], Jisheng Xie[1], Hai-jing Yin[1], Ya-wen Zhang[1], Colin Ophus[2], Jihan Zhou[1]

[1]Peking University, [2]Lawrence Berkeley National Lab

lizezhou2015@pku.edu.cn

Deciphering the three-dimensional atomic structure of solid-solid interfaces in core-shell nanomaterials is the key to understand their remarkable catalytical, optical and electronic properties [1,2]. Here, using atomic resolution electron tomography [3-5], we probe the three-dimensional atomic structures of palladium-platinum core-shell nanoparticles at the single-atom level [6]. We successfully quantify the rich structural variety of core-shell nanoparticles with heteroepitaxy in 3D at atomic resolution (Fig. 1). Instead of forming an atomically-sharp boundary, the core-shell interface is atomically diffuse with an average thickness of 4.2 Å (Fig. 2), irrespective of the particle's morphology or crystallographic texture. We observed dissolved free Pd and Pt single atoms and sub-nanometer clusters using cryogenic electron microscopy. The high concentration of Pd in the diffusive interface is highly related to the free Pd atoms dissolved from the Pd seeds. These results advance our understanding of core-shell structures at the fundamental level, providing potential strategies into precise nanomaterial manipulation and chemical property regulation [7].

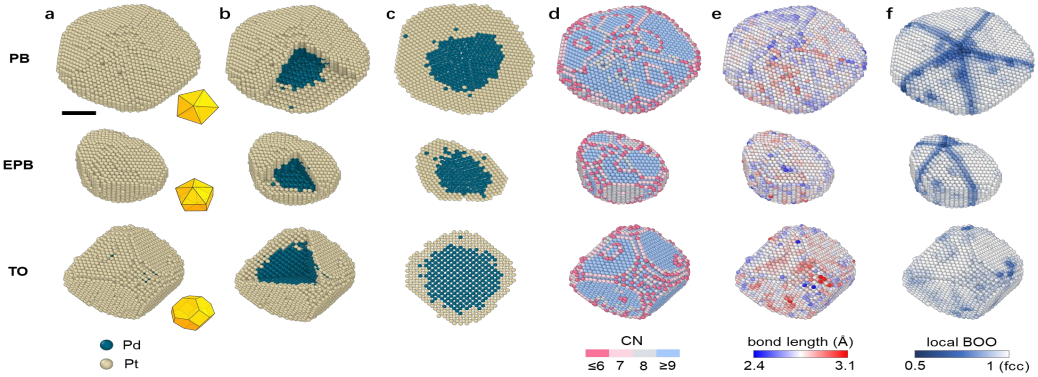

Figure 1

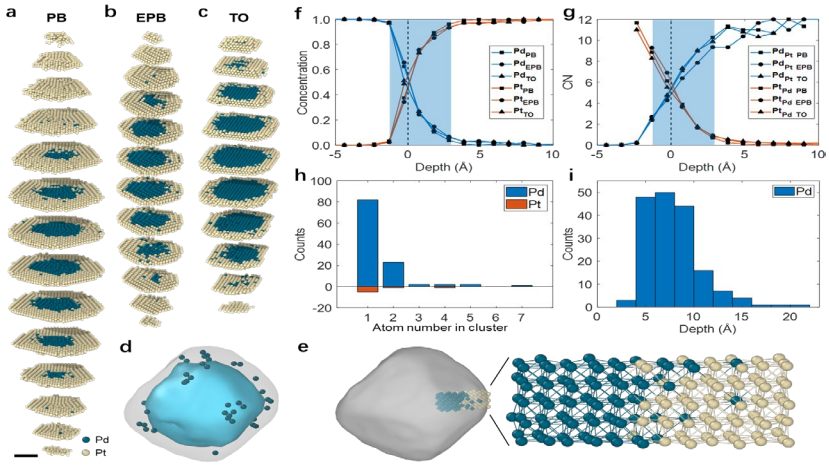

Figure 2