In situ Transmission Electron Microscopy experiments on individual nanoparticles

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Abstract

The behavior of oxides at the nanometer scale strongly differs from the one of the corresponding bulk materials. Indeed, large plasticity has already been reported, even at room temperature [1, 2]. Yet, the plasticity of nanoparticles has not really been exploited, probably because the mechanisms are usually not evidenced. We will present *in situ* mechanical tests on individual oxide nanoparticles, using Transmission Electron Microscopy. The key steps, from sample preparation to data processing, will be presented. The case of cerium oxide (CeOx) nanoparticles with sizes between 20 and 130 nm will be described. Interestingly, the same particles can be tested with two different structures (bixbyite / fluorite), depending on irradiation conditions (high / low dose rate) and gaseous environment (under vacuum / in air). The deformation mechanism will be evidenced for each crystal structure and compared with simulations results. The differences in the mechanisms will be discussed as a function of the fraction and arrangement of oxygen vacancies. Finally, the evolution of the yield stress vs the nanoparticle size will be analyzed for both crystal structures, similarly to what was performed on MgO [3, 4].

References

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Figures

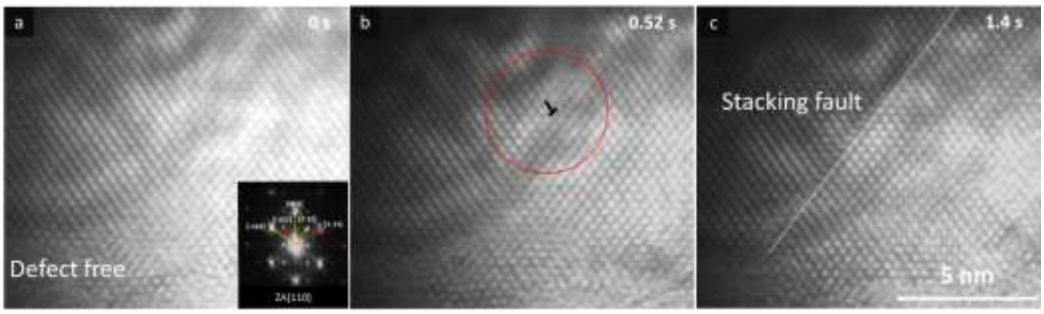

Figure 1: *In situ* generation of a stacking fault in a $CeO_{1.5}$ nanocube that was initially defect free.