Fabrication and characterization of nanoscale heterogeneous interfaces of epitaxially grown anatase-type TiO2 on CeO2 nanocubes

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Heterogeneous interfaces have been drawing much intention so far. Particularly, nanoscale heterogeneous interfaces are attractive because of quantum confinement effects. To fabricate nanoscale heterogeneous interfaces, we use nanocrystals that fixed to the surface as a nanoscale substrate. In order to apply nanocrystals to the surface, at least three things have to be considered. 1) Dispersing nanocrystals in a solvent. 2) Self-assembling the nanocrystals on the substrate with drying the solvent. 3) Fixing the nanocrystals on the substrate. Among these processes, necessary interaction between the inorganic cores, modifiers, solvent, and the substrates is totally different. This could then lead to a difficulty to apply nanocrystals to the surface macroscopically uniformly.
We have so far synthesized decanoic acid modified CeO2 nanocubes to disperse those nanocubes in cyclohexane [1] and modified silicon substrates so that chemical bonding could be constructed between the nanocubes and those modified surfaces to fix them during self-assembly. [2, 3] Once the nanocubes are fixed to the substrate, monolayer structure of nanocubes can be fabricated macroscopically by washing residual nanocubes on the monolayer.
In this presentation, nanoscale epitaxy for fabricating nanoscale heterogeneous interfaces is demonstrated combining bottom-up and top-down processes. TiO2 sputtered was selectively nucleated and grown on individual CeO2 nanocubes used as a nanoscale substrate fabricating TiO2/CeO2 tandem nanocrystals (Fig. 1). The heterogeneous interfaces were then fabricated between anatase TiO2 (001) and CeO2 (001) nanocube such that the anatase TiO2 [110] directions were parallel to the CeO2 [100] directions. [4] The result of ultraviolet-visible spectroscopy of TiO2/CeO2 tandem nanocrystals will be also discussed in this presentation.

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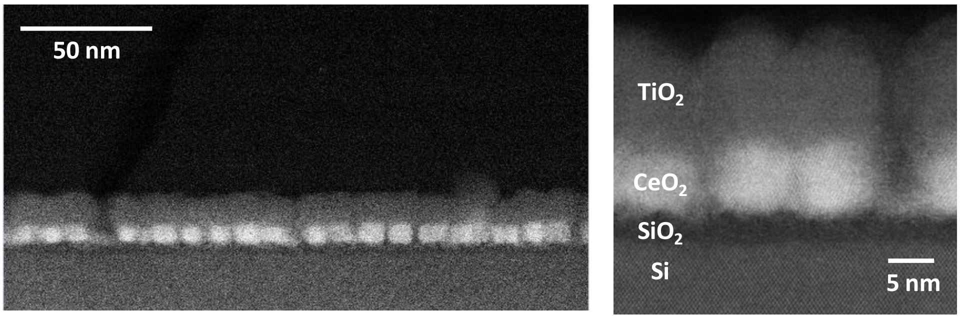

Figure 1. Cross-sectional transmission electron microscope images of heterogeneous interfaces between anatase TiO2 and CeO2 nanocubes.

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Fields of Research

Nanomaterials, Thin film deposition

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