

Effect of Silica Coating on Titania Nanocrystal Stability

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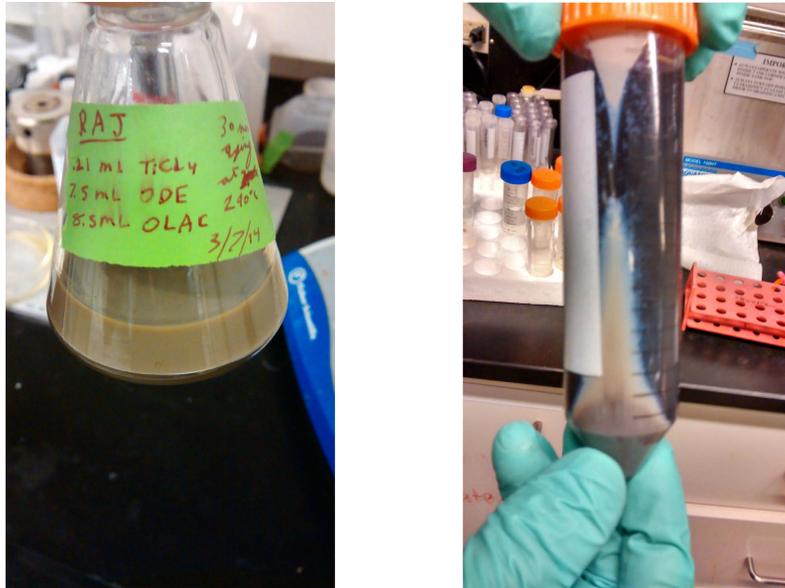
Graduation: May 2017

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Introduction:

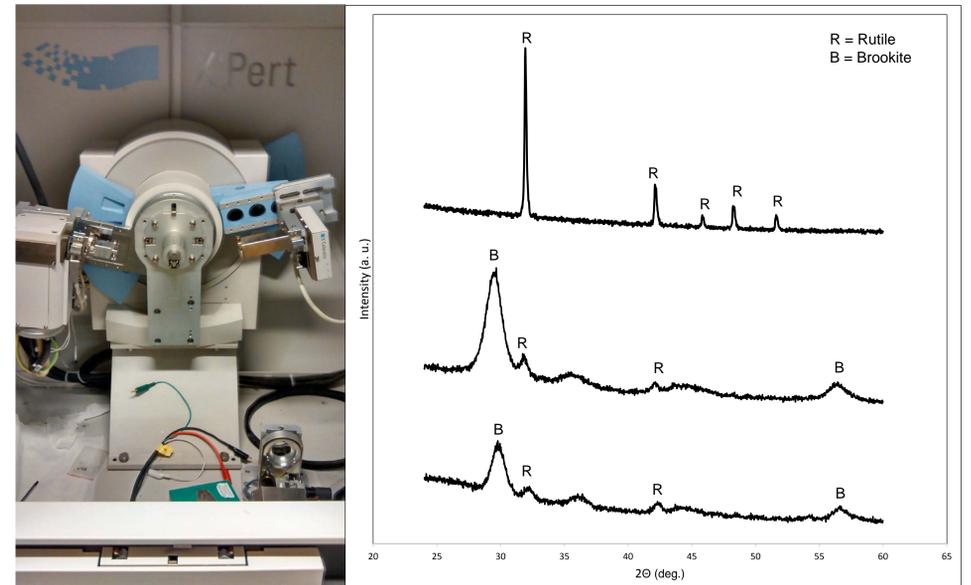
The obtained nanorods were coated with silica using tetraorthosilicate and heated at elevated temperatures for various time periods. The coating step was used to prevent any particle interaction and to monitor its effect on rutile nucleation. X-ray powder diffraction and transmission electron microscopy with the purpose of exploring the nucleation mechanism and the effect of silica on nucleation. Titania has enormous potential applications in dye-sensitized solar cells.

1. Brookite Nanorods Were Synthesized



Left: brookite solution in OLAC and ODE from $TiCl_4$ precursor
Right: Isolated brookite nanoparticles

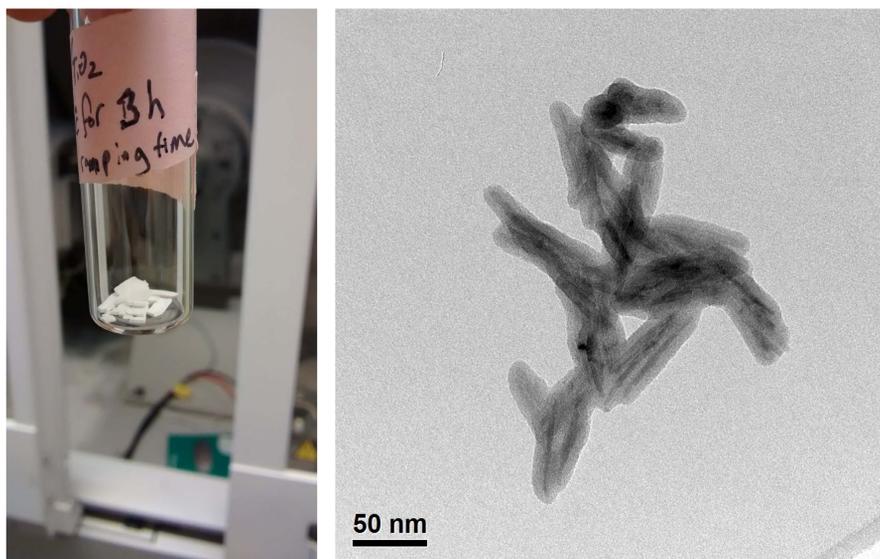
2. XRD of Brookite



XRD analysis was used to prove that synthesized nanoparticles were indeed brookite

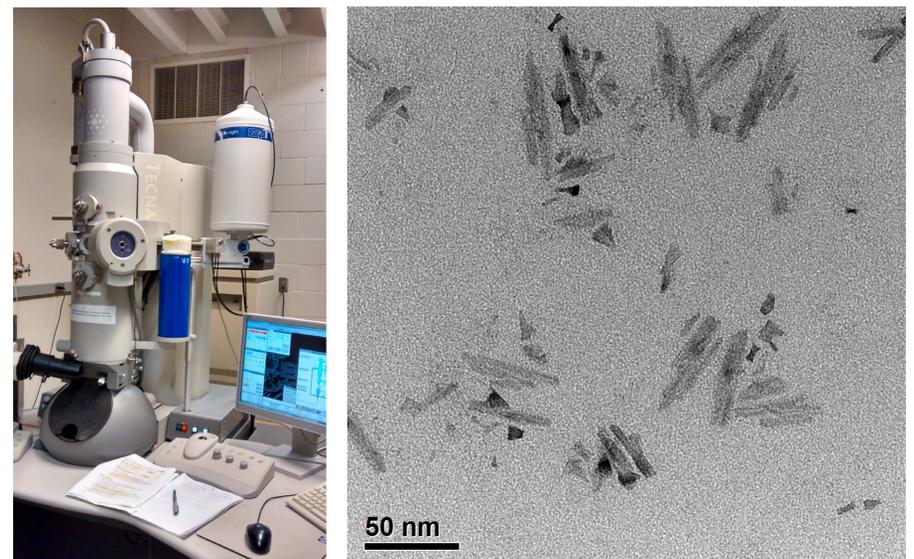
Plot: rutile (top), silica coated brookite (middle), brookite (bottom).

4. Brookite Nanorods coated with Silica



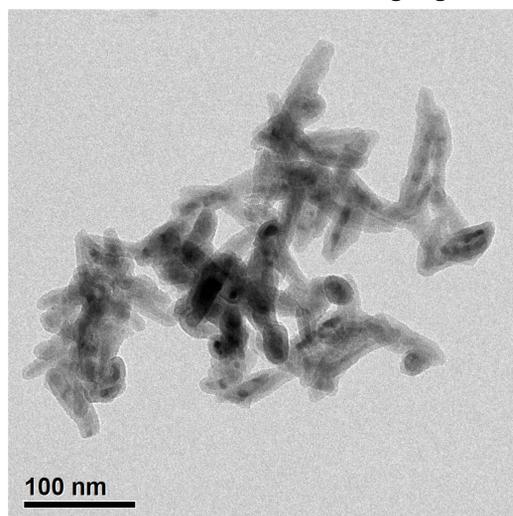
Left: Silica coated brookite
Right: TEM image of silica coated brookite

3. TEM of Brookite Nanoparticles



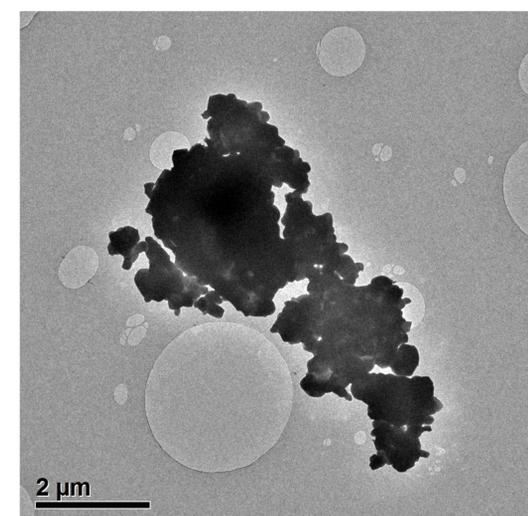
Left: Transmission Electron Microscope used for nanoparticle imaging
Right: Images of uncoated brookite nanorods for analysis of before and after of brookite aging in furnace

6. TEM of Coated Brookite after aging in Furnace



TEM of brookite nanoparticles which have not undergone nucleation, after heating at $900^\circ C$ for 5 hours, due to silica coating.

5. TEM of Uncoated Brookite to Rutile after aging



TEM image of nucleated rutile after aging in furnace at $900^\circ C$ for 5 hours. Note the large size of particles.

Results:

TEM analysis of the silica coated as well as uncoated titania nanoparticles show that the brookite to rutile transformation is completely stopped when brookite is coated with silica, even at $900^\circ C$. Uncoated brookite, on the other hand, shows complete transformation from brookite to rutile. This shows that nucleation of titania is strongly dependent on whether or not the nanoparticles come into contact.