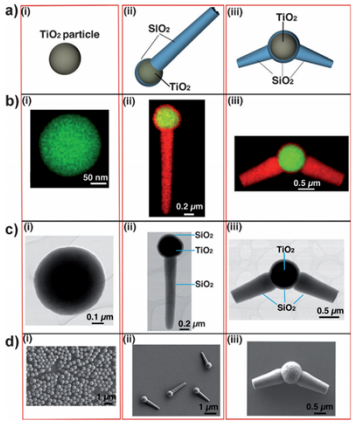
Exquisite Control During Growth to Create Complex Oxide Microstructures



TiO_2–SiO_2 hybrid structures obtained by spike growth on TiO_2 particles: a) Schematics, b) EDS maps (TiO_2 particle: green; SiO_2 spikes: red), c) BF-STEM images, and d) SEM images of (i) single TiO_2 particle, (ii) TiO_2 particle with one spike, and (iii) TiO_2 particle with two spikes.

Scientific Achievement

A robust solution-phase process to synthesize complex silica and silica–titania hybrid microstructures was developed to build complex hybrid structures.

Significance and Impact

Emulsion droplet based growth demonstrated in this work opens up opportunities for creating rationally designed complex structures with multi-scale organization of constituting parts.

Research Details

- Emulsion droplets made of polyvinylpyrrolidone (PVP) were used to promote spike growth when mixed with tetraethyl orthosilicate (TEOS)
- A wide range of silica and silica-titania hybrid microstructures were created, including dimers, smooth spikes, corrugated spikes, and platelets.

Work was performed as a User Project at the Center for Nanophase Materials Sciences.

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Narrative Highlight Text:
In this work, we exploit the emulsion droplet8d based growth of silica structures to synthesize a wide range of microstructures made of pure silica (silicon dioxide; SiO2) and hybrid microstructures made of silica and titania (titanium dioxide; TiO2). This approach provides a high degree of control of (1) shape, (2) size, (3) number (less or more), and (4) composition of different parts of the structures. Starting from a spherical particle, we synthesized complex SiO2 structures such as central particle surrounded by smooth spikes, corrugated spikes, or plates. We further extended this strategy and synthesized hybrid complex microstructures comprised of one segment of titania and the other of silica. Many unprecedented structures such as a silica double plate sandwiched between two particles, trigonal made of plates sandwiched in a particle trimer, and two silica trigonals made of 4 plates sandwiched between a particle quadruple were also obtained by allowing the controlled deposition of silica.

Reference

"Step-by-step Growth of Complex Oxide Microstructures"
Panos Datskos,[1] David A. Cullen,[2] and Jaswinder Sharma[1]
[1] Nanosystems, Separations, and Materials Research Group Energy and Transportation Sciences Division, Oak Ridge National Laboratory; [2] Microscopy Group, Material Science and Technology Division, Oak Ridge National Laboratory
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