金薄膜上および溶液中でのレーザー水熱合成によるVO_2合成

Laser-induced hydrothermal synthesis of VO_2 on gold thin film and in solution

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Vanadium dioxide (VO_2) is known as a phase-transition material: Whereas the semiconducting, monoclinic phase VO_2(M) is stable at room temperature, a transition to the metallic, rutile-like tetragonal phase VO_2(R) occurs when the material is heated above a critical temperature (around 68℃). This insulator-to-metal phase transition leads not only to a drastic change of the electrical conductivity of the material, but also to a change of its optical properties. For those reasons, VO_2 has been used in the fabrication of thermochromic windows and electronic switches [1].

In this study, we investigate the growth of VO_2 nanocrystals and microparticles using a laser-induced hydrothermal synthesis method [2]. First, a 1064 nm-laser beam was focused onto the surface of a gold thin film (30 nm thickness). The synthesis of particles was observed when a critical laser intensity is reached. However, due to the combined light absorption of gold and vanadium oxide, high temperatures are easily reached leading to the formation of microbubbles and to damages of the gold thin film. The synthesis of vanadium oxide was confirmed by EDS measurements performed on nanocrystal structures synthesized at the bottom of a microbubble.

Using a high magnification (100x) and high NA (0.8) microscope objective, synthesized particles were optically trapped in the precursor solution using a Gaussian laser beam (1064 nm, 9 mW). Because of the light absorption, the particles were trapped close to a glass surface. Dark-field microscopy images show that the synthesized particles were trapped at a distance away from the beam center following an orbital trajectory. This phenomenon is a typical feature of the insulator-to-metal phase transition-induced optical force reversal occurring when VO_2 particles are optically trapped. Further analysis of the particle dynamics will be performed to investigate the optical forces acting on the trapped particles during the VO_2 growth process.

We expect our new laser-induced hydrothermal synthesis method to enable nanoscale control over the position and material properties of the synthesized VO_2 nanostructures.

REFERENCES:

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