Low-temperature synthesis of nano-patterned TiO_2 thin films by combining sol-gel synthesis and nano-imprinting

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Abstract

Nanostructured titania thin films are widely used in a variety of applications such as photovoltaics, photocatalysis, and gas sensing. For the hybrid solar cell applications, a large surface-to-volume ratio of the inorganic semiconductor is needed, because the morphology influences charge carrier transport routes and the exciton dissociation, which occurs at the interface of the inorganic and the organic parts, and therefore the probabilities of electron-hole recombination. The optical, electrical, and catalytic properties of TiO_2 could be tuned by its morphology.

In the present work a low-temperature route is used to obtain a mesoporous titania thin films with a foam-like morphology, which is attractive for many applications requiring moderate use in energy input or low temperature processing. The synthesis combines sol-gel chemistry with block copolymers as structure directing templates. Using the thermal press nanoimprinting lithography technique, an additional superstructure in the range of tens of nanometers is imprinted on the surface of the titania thin films to increase the surface area. In addition, the films are investigated for the efficiency of backfilling for the application for the hybrid solar cells.

To investigate the nanostructure of the thin films, scanning electron microscope (SEM) and the atomic force microscope (AFM) are used to get information about the surface of the films in the real space. In the reciprocal space, the grazing incidence small angle x-ray scattering (GISAXS) is used to get morphological information from inside the thin films. The optoelectronic properties of the films are characterized by the UV/Vis spectroscopy.