Exploration of Cr-TiO_2 Nanorods Growth for Solar Applications

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Solar energy is one of the most effective long-term alternative measures to replace fossil fuels due to its natural abundance. This dominant advantage can fully support stringent global energy demand for future. Unfortunately, solar application only contributes less than 0.1% of all the consumed powers nowadays because of a variety of encountered issues, such as insufficient absorption of the sun light, poor power conversion rate, lack of suitable materials, and high manufacturing cost. Therefore, significant improvement is inevitably needed before its wide applications.

High aspect ratios of semiconductor oxides such as nanorod structures provide great potentials in the application of solar energies, resulting from much higher active surface area for solar absorption and efficient charge transfer. TiO_2 nanorods are one of the promising candidates because of their diverse properties. In this talk, the hydrothermal and sputtering techniques to make the TiO_2 nanorods will be discussed.

In the hydrothermal approach, different manufacturing parameters, such as precursors, the morphology of the seed layers, and annealing temperatures, will be discussed to understand the growth of the TiO_2 nanorods. Aligned single crystal TiO_2 nanorods have been made and their growth is extremely dependent on the morphology and temperatures of the substrates. As a result, higher temperatures with suitable seed layers are necessary for making good quality of TiO_2 nanorods.

In the sputtering approach, a template technique is used to trigger the growth of the TiO_2 nanorods. Various working pressures, powers, and substrate morphology are tuned to optimize the growth of TiO_2 nanorods. In addition, TiO_2 is a wide band gap semiconductor, resulting in absorption of only the UV range of the solar spectrum, which definitely affects the energy conversion efficiency, and accordingly brings in the concerns of high cost. We dope chromium (Cr) into TiO_2 nanorods to modulate their band gaps to extend their applications in photocatalysts. Through combining both strategies of the bandgap tuning and nanorod structures, much better solar characteristics of TiO_2 can be expected.