

Growth of Seeded Pine-Tree Anatase TiO₂ Nanotubes for Solid-State Dye-Sensitized Solar Cells

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Hierarchical pine tree-like TiO₂ nanotube (PTT) arrays were prepared on the transparent conducting oxide substrate by facile and effective hydrothermal reaction. PTT arrays were constructed by seeding TiO₂ layer with vertically aligned long nanotubes (NT) and short nanorod (NR) branches. In order to fabricate various morphologies of PTT layers, the water/diethylene glycol ratio was adjusted with various compositions. With increasing water ratio, the diameter of NTs and size of NR branches decreases. Also, PTT arrays could be get higher up to 19 μm and its charge transport and specific surface area were improved considerably. The 19 μm long PTT arrays exhibited a significant energy-conversion efficiency of 8.0% at 100 mW/cm², which is twice higher than that of commercial TiO₂ paste (4.0%), and for N719 dye-based solid-state dye-sensitized solar cells (ssDSSCs), one of the highest values was achieved. Its large surface area, reduced electrolyte/electrode interfacial resistance, and improved electron transport results in the high performance of ssDSSCs.