Dye-sensitized solar cells based on the Ag-incorporated freestanding TiO_2 nanotube arrays with scattering layer

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Dye-sensitized solar cells (DSSCs) were fabricated with open-ended freestanding TiO2 nanotube arrays incorporated with Ag nanoparticles in the channel as plasmonic effect and coated with large-sized TiO2 nanoparticles as scattering effect for improving energy conversion efficiency. Compared to DSSC based on the closed-ended freestanding TiO2 nanotube arrays without Ag and large-sized TiO2 nanoparticles, the energy conversion efficiency of DSSC with Ag and TiO2 nanoparticles is increased from 5.86% to 6.71%. Moreover, compared to DSSC based on the closed-ended freestanding TiO2 nanotube arrays with Ag and large-sized TiO2 nanoparticles, the energy conversion efficiency of DSSC based on the open-ended freestanding TiO2 nanotube arrays is increased from 6.71% to 7.05%. We demonstrate that each component like Ag nanoparticles, large-sized TiO2, and closed-ended or open-ended TiO2 nanotube array enhanced the energy conversion efficiency, and all components exhibited the highest energy conversion efficiency in DSSCs.