Fabrication of crack-free porous TiO_2 photoelectrodes by templating randomly packed 3D colloidal crystals

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Recently, colloidal particles have attracted of great interest because of potential in broad applications. The success of applications depends on the properties of colloidal building block such as sizes and surface property, and their self-assembly into crystalline arrays. However, three dimensionally (3D) ordered colloidal crystal films using self-assembly process inevitably resulted in the formation of cracks, domain boundaries, and other defects due to maximal packing density. Therefore, we synthesized uniform polystyrene (PS) colloidal particles with different sizes and then assembled 3D colloidal crystals using the mixture of PS colloidal building blocks with different sizes. After finding the combination of PS colloids for crack-free 3D colloidal crystals, we templated its structure with TiO_2 colloidal particles. After removing of the PS particles by calcination at 500°C, we can get crack-free porous films which can be used as photoelectrodes in solar cells because of lower packing density of PS colloidal mixture particles.