I will introduce the synthesis of well-organized mesoporous TiO$_2$ films templated by the organized graft copolymer, i.e. poly(vinyl chloride)-graft-poly(oxyethylene methacrylate) (PVCgPOEM) as a structure directing agent. Well-organized mesoporous TiO$_2$ films with high porosity and excellent channel connectivity were developed via the sol gel process using PVCgPOEM graft copolymer synthesized by atom transfer radical polymerization (ATRP). The careful adjustment of copolymer composition and solvent affinity using a THF/H$_2$O/HCl mixture was used to systematically vary the material structure. Despite organized morphology, the thickness of sol-gel derived TiO$_2$ film via a spincoating process is often limited to the submicron scale due to crack formation during calcination. Our group recently reported micrometer thick, mesoporous TiO$_2$ films templated by PVCgPOEM, via the addition of the P25 nanoparticles. TiO$_2$ nanospheres with hierarchical pores were also prepared using the combined process of ATRP and sol-gel process. In addition, 3-dimensional (3D) nanostructured TiO$_2$ photoelectrodes with interconnectivity, high surface area and bimodal pores were synthesized using a graft/crosslink polymerization and sol-gel process. Track-etched polycarbonate (PC) membranes were also used as a soft template to synthesize mesoporous TiO$_2$ nanowires or nanotubes and the relation between structure and efficiency was systematically investigated. Finally, we introduced solid-state polymerizable conductive monomer with good conductivity and penetration to I$_2$-free solid-state DSSCs, which involves easily accessible and widely applicable fabrication method. A graft copolymer-templated, organized mesoporous TiO$_2$ film with a large surface area was also prepared using spindle-shaped, preformed TiO$_2$ nanoparticles.

References