TiO$_2$/polydiacetylene nanocomposites fabricated by photosensitized solid-state polymerization

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TiO$_2$/polydiacetylene nanocomposites were created by in-situ topochemical polymerization of diacetylene monomers within nanoporous TiO$_2$ thin films under visible light irradiation. Both UV-vis absorption and Raman studies confirmed that the diacetylene monomers were successfully photopolymerized. Since photopolymerization of diacetylene is typically induced by excitation of the monomer with UV irradiation (at $\lambda < 300$ nm), the observed red shift of the photopolymerization wavelength is attributed to the photosensitization effect of TiO$_2$. The morphological study of the TiO$_2$/polydiacetylenenanocomposite revealed that the diacetylene monomers were polymerized in the vicinity of the TiO$_2$ nanoparticles. This can be ascribed to the fact that the electron-transfer process occurs at the interface of the TiO$_2$ nanoparticle and the diacetylene monomer and the polymerization is expected to be initiated near the TiO$_2$ surface.

Since visible light can transmit through the entire nanoporous TiO$_2$, it is possible to obtain uniform polymerization of diacetylene inside the TiO$_2$ nanopores. The TiO$_2$/polydiacetylene nanocomposites, combining the optical and electronic characteristics of the polydiacetylenes and the semiconducting properties of TiO$_2$, may provide a new approach toward development of optoelectronic devices. Polymerization of conjugated polymers in nanostructured semiconductors are of great importance as sensitizers and as hole conductors for organic solar cell applications.