Investigating the nanostructural evolution of TiO2 nanoparticles in the sol-gel derived TiO2-polymethyl methacrylate nanocomposites

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Abstrak

Nanocomposite thin films consisting of titanium oxide, or TiO2, nanoparticles embedded in apolymer matrix represent a new class of potential materials for optoelectronic applications such as optical switches, waveguides, high refractive indices and non-linear optical devices. Among the various processing techniques under development for these nanocomposites, the in situ sol−gel process is known to be versatile as it enables control of the inorganic-organic interaction at various molecular, nanometer, and micrometer scales. However, the sol−gel process has a major limitation, which is the low crystallinity in the resulting TiO2 phase due to relatively low processing temperatures. Therefore, the current research is aimed at investigating the nanostructural evolution of theTiO2 crystallite during the in situ sol−gel process to gain a better understanding of the mechanisms responsible for the largely amorphous nature of TiO2 nanoparticles. For this purpose, two sol−gel parameters, i.e., the hydrolysis ratio (Rw) and pH value of the TiO2 precursor solution were varied. On the basis of XRD and FTIR analyses, it was found that the largely amorphous TiO2 state is related to the fast development of stiff Ti−OH networks during the hydrolysis and condensation stag es of the sol−gel process, and concurrently worsened by the formation of the rigid PMMA matrix upon thermal annealing.