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Effect of Metal Nanoparticles on Thermal Stability of Polymers

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Palladium (Pd) nanoparticles were incorporated into polymer films by a dry process consisting of simultaneous vaporization, penetration and reduction steps of palladium(II) bis (acetylacetonato), Pd(acac)2, used as a precursor. Using this process, we attempted to incorporate the Pd nanoparticles into crystalline polymers, such as syndiotactic polystyrene, polypropylene, polyamide 6 and polyethylene terephthalate. The effect of this process on the structures and the properties of the polymer films were investigated. We found that the uniformly dispersed Pd nanoparticles enhanced the thermal stability of addition polymers even when the Pd content was quite low less than 1 wt%, while they were harmful to that of condensation polymers. The distributions of Pd nanoparticles in the host polymers were observed by transmission electron microscopy (TEM), and dynamic and isothermal thermogravimetric (TG) analyses were carried out to estimate the effect of Pd nanoparticles on the thermal degradation characteristics. The dynamic TG data were introduced to Kissinger equation to investigate the mechanism of the effect of the Pd nanoparitcles on the thermal stability. The enhancement of thermal stability in addition polymers was mainly due to the hindrance of the mobility of polymer chains by the Pd nanoparticles, while the deterioration of condensation polymers was mainly attributed to the decrease in the activation energy due to the catalytic role of the Pd nanoparticles.