P - 18

GRAFTING OF POLYMER ONTO SILICA SURFACE IN THE PRESENCE OF γ-RAY IRRADIATED SILICA

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We have reported the graft polymerization of vinyl monomers initiated by surface radicals formed by the decomposition of azo and peroxide groups previously introduced onto the surface. In addition, the grafting of polymers onto carbon black has been reported by the reaction of polymer radicals with the surface. On the other hand, it is well known that the relatively stable radicals are generated on the surface by the γ-ray irradiation. In this paper, the grafting of polystyrene onto silica surface during the thermal polymerization of styrene in the presence of γ-ray irradiated silica, grafting mechanism and thermal stability of grafted polymer will be discussed. The grafting of polymers onto silica surface by irradiation of polymer-adsorbed silica was also investigated.

Silica obtained from Mitsubishi Chemical Co., Japan was used after pulverization: the particle size was 0.037-0.088 mm. Irradiation was performed in Cs-137 source at room temperature. The silica was irradiated at 50 Gy with dose rate of 3.463 Gy/min. Into a polymerization tube, styrene and irradiated silica was charged and the polymerization was carried out under argon under stirring. The percentage of polystyrene grafting was determined from weight loss when polystyrene-grafted silica was heated at 600 °C by a thermal analyzer. Untreated silica did not affect the thermal polymerization of styrene. On the contrary, the thermal polymerization of styrene was remarkably retarded in the presence of the irradiated silica at 60 °C. Similar tendency was reported during the polymerization of vinyl monomers in the presence of carbon black. In the initial stage of the polymerization in the presence of the irradiated silica below 50 °C, the polymerization was accelerated. During the polymerization in the presence of irradiated silica, polystyrene was grafted onto the surface: the percentage of grafting was 5-11%. The amount of polystyrene grafted onto silica surface at 50°C was more than that at 80 °C, indicating the difference of molecular weight of polystyrene and polymerization mechanism.

It is concluded that at lower temperature, the grafting based on the propagation of polystyrene from surface radical preferentially proceeded, but at higher temperature, the coupling reaction of propagating polymer radical with surface radical was determinating. Unextractable polymer remained on the silica surface by the γ-ray irradiation of polymer-adsorbed silica.