

380f Electron-Beam Hardening of Functionalized Polynorbornene Thin Films

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Polymers based on norbornene have been used for low-k dielectric materials, advanced photoresists, and as sacrificial materials in the formation buried air-gaps. In this study, the hardness of thin films of butylpolynorbornene - triethoxysilylpolynorbornene copolymer was enhanced by exposure to electron beam radiation. The effect of electron energy, dose, and temperature on the thermal and mechanical properties of the irradiated copolymer films was investigated using dynamic thermal gravimetric analysis and nanoindentation. The hardness of the copolymer thin films was increased by electron beam irradiation; however, the thermal stability was degraded. Electron beam exposure caused bond cleavage that led to beneficial crosslinking and subsequent (undesirable) oxidation. The degree of oxidation depends on the electron energy and dose. By using a mixture of 2 vol% H₂ and 98 vol% N₂ as the electron beam process gas and a post exposure heating in prior to air exposure, the oxidation of the copolymer was reduced, and the thermal stability was improved.