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CHARACTERIZATION OF TRANSPARENT SILICA FILMS DEPOSITED ON POLYMERIC MATERIALS

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Silica has been applied in a wide variety of industrial fields because of its excellent properties. Recently, silica coatings have attracted particular attention as barrier coatings against gas and vapor permeation. Among many coating methods, plasma-enhanced chemical vapor deposition (PECVD) is one of the preferred methods to deposit silica films on polymeric substrates at low substrate temperature. In the present work we studied film structures of silica deposited by PECVD under various deposition conditions and effects of film structures on their gas barrier properties.

Silica films were synthesized by capacitively coupled RF PECVD using mixtures of organosilane and oxygen as a source. The chemical bonding states and compositions of the films deposited were evaluated with FTIR and XPS. Film surfaces and cross-sections were observed by SEM. Oxygen transmission rates (OTR) of the films coated on polyethylene terephthalate (PET) substrates were measured by an isopiestic method.

The SEM images obtained clearly demonstrated that silica domes formed on the PET substrates only in the early stage of deposition. Silica domes did not form in the vapor phase, but rather, directly onto the polymer surface. The growth of these silica domes depended on the presence of activated oxygen species in the vapor phase. When no oxygen existed in the vapor phase, the domes did not connect well with each other even after long deposition time. In such cases, the siloxane networks in the film were terminated with many functional groups, such as -CH_x, -H and -OH. On the contrary, in the presence of active oxygen species, many types of impurities in the film were largely eliminated, with the result that a dense silica film in which the domes fused together well could form on the PET substrate. The densely-packed silica film satisfied the requirements for industrial products in the field of food packaging.

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