Change in Water Vapor Permeability of Polymer Films Treated with Osmium Tetroxide

Osmium tetroxide staining of polymers containing unsaturated carbon bonds has been used extensively to increase the effective contrast in electron micrographs.[1–3] Sperling et al.[4] have investigated the diffusion-controlled kinetics of the staining process in poly(butadiene-*co*-styrene)/polystyrene interpenetrating polymer networks. Even polymers which do not contain double bonds stain noticeably with OsO_4, e.g., the polyurethane-containing interpenetrating polymer networks.[3] In this note we examine the question of whether physical properties other than optical (or electron optical) opacity are affected by OsO_4 staining of saturated, thin (1 mil) commercial polymer films. To investigate this, we examined the water vapor permeability of OsO_4-treated and untreated films.

We suspended 1-mil-thick films of a commercial copolymer of poly(vinyl chloride)–poly (vinyledene chloride) (trade name Saran) and a polystyrene (trade name Trycite) in the vapor over room-temperature liquid OsO_4 for two days. The treated films were uniformly darkened, and the weight gain of 2.1-cm discs, weighing 0.13 g, of these films after treatment was in the neighborhood of 10^{-4} g. The water vapor premeabilities of treated and untreated films were determined using a modified cup technique[5,6] at 22 ± 0.5°C (vapor pressure of water of 2.007 cm Hg). In Table I we list the water vapor permeabilities of the untreated and OsO_4 treated films. In each case an appreciable loss of water vapor permeability resulted from the OsO_4 treatment. The optical darkening of the film appears to be unaffected by the water transmission. The magnitude of the effect is quite large (more than twofold for the polystyrene and almost threefold for the other film). While it is tempting to speculate that this is due to some chemical reaction with monomer, polymer, or film additive which affects the permeability tortuosity factor, we have not been able to demonstrate this experimentally.

TABLE I
Water Vapor Permeabilities

Film material	Permeability of untreated film, 10^{11} g-cm/cm^2-cm Hg-sec (average of three runs)	Permeability of OsO_4-treated film, 10^{11} g-cm/cm^2-cm Hg-sec average of three runs)
Poly(vinyl chloride)–poly(vinyledene chloride) (Saran)	0.58	0.21
Polystyrene (Trycite)	18	8.0

This work was supported by the National Science Foundation and the U.S. Army Research Office.

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Journal of Applied Polymer Science, Vol. 23, 1583–1584 (1979)
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Received January 30, 1978
Revised June 21, 1978