NOTES

Reducing Properties of Plastics Etched in Chromium Acid Solutions

In the course of etching by strong oxidizing agents, the easily oxidizable fractions and amorphic districts are first removed from a plastic surface, therefore, the rest of the surface should possess less reducing capacity. Nevertheless, there are indications that the etched surfaces of such plastics as copolymers of styrene, polyethylene, and polypropylene possess significant reducing properties.[1] Metal ion reduction accounts for the fact that, when the etched surface is immersed in the acidic palladium salt solution (ionic activation), a certain amount of palladium (sufficient for the initiation of electroless plating reaction) remains on the surface.[2–4] Evidently, a proper reducing agent for this is carbon monoxide (CO), which was produced in the process of etching.[5] The CO formed in the etching reaction, is first absorbed by polymeric material and then rediffuses from it and reduces palladium ions on the surface. To prove this concept, we carried out some tests with polyethylene films.

The palladium salt solution ($PdCl_2$, 1.5 g/L) for the detection of CO was prepared by dissolving metallic palladium in a mixture of nitric and hydrochloric acids.[6]

For the control tests, CO was prepared by mixing HCOOH with H_2SO_4 at 75°C. When CO was bubbled through the palladium salt solution in the test tube, the inner surface became dark within 1–2 min, and after 15–20 min a layer of metalllic palladium was formed. A similar effect was observed in the case when CO was produced within a polyethylene film bag immersed in the palladium chloride solution and a metallic palladium layer on the external surface of the polyethylene bag formed.

Similar results were obtained when pieces of ABS-plastic (20 dm^2/L) were etched in chromium acid solution at 75°C and the evolved gases were bubbled through the palladium salt solution in the test tube; after 5 min the inner surface became dark, and after 20 min a metallic palladium film of noticeable thickness was formed.

This phenomenon was also observed when a polyethylene film bag was etched on one side in the chromium acid mixture at 80°C, while the other side was in contact with the palladium salt solution so that gases evolved in the etching process could percolate through the film and interact with palladium ions on the other surface of the polyethylene film. The side of the polyethylene film bag filled with etching solution, which was in contact with the palladium salt solution, was covered with a metallic palladium film.

Etching of plastics by oxidation lowers the reducing properties of the surface by removing easily oxidizable components. It also increases the reducing power by forming new reducing agents in the polymer.

The tests also confirm that CO can be a reducing agent for palladium (II) ions in the activation processes. Furthermore, it is possible to obtain rather thick metal films on the polymer surface by percolating reducing agent through the polymeric material.

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