Copper Plating on Poly Tetrafluoroethylene (PTFE)

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Plating of copper on poly (tetrafluoroethylene), PTFE, has beeri carried out using multistep conditioning, activation and electroless process. A treatment using pyridinium poly (hydrogen fluoride) in presence of metals on PTFE produces a surface over which a dense cluster deposit of copper can be formed as shown by SEM studies of treated and untreated PTFE surfaces.

Poly(tetrafluoroethylene) is an important engineering material as it combines unusual characteristics of chemical inertness with such physical properties as low dielectric constant, low coefficient of friction and high thermal stability. This enables it to be used in electrical and electronic applications • [1]. Depositing a copper layer on PTFE acquires importance in electronic circuitry (2]. However, PTFE being chemically inert, it is difficult to condition the surface using the normal procedure adopted for plastics. Methods such as, pressing of copper film on PTFE and selective chemical vapour deposition process (3), have been known and reported in literature. In this paper, a simple electroless process of plating PTFE followed by electro deposition of copper is described.

EXPERIMENTAL

PTFE sheets (1" x 1" x 0.1") are treated with pyridinium poly(hydrogen fluoride), PPHF, in presence of metal powders [4). The treated sample is washed with water. dried and dipped in a solution containing chromic acid, sulphuric acid and hydrofluoric acid for 10 minutes at 50^0C. The acid solution is washed away thoroughly from the sample, then rinsed in distilled water and dipped into a solution containing sodium dithionate and sodium hydroxide. This process removes any chromium remaining on the surface. The strips are then dipped in HC1 (10%) to neutralise any entrained alkali and thoroughly washed.

The strips are now dipped in a catalyst solution containing palladous chloride, hydrochloric acid and stannous chloride. The catalyst treatment is carried out under ultrasonic stirring which produces a uniform layer of palladium on the surface. The surface is treated with fluoroboric acid to remove any excess metal.

The strip is now plated with copper using electroless copper solution consisting of copper sulphate, EDTA, formaldehyde and a stabiliser (3).

Copper plating of PTFE is continued for 30 mins during which time a plating thickness of 2 gm is attained. Electroplating of copper is carried out on this at a current density of 20 mA/ cm2 for one hour to get a thickness of 20 um.

SEM photographs on the following PTFE samples were taken using SEM. S 360, Leica, Cambridge instruments: (a) untreated and (b) treated with (PPHF), (c) untreated - electroless plated (d) treated - electroless plated, (e) untreated - copper electroplated and (f) treated -copper electroplated (fig. 11.

RESULTS AND DISCUSSION

The electroplated copper is subjected to tape peel off test which shows that the adhesion is moderate. There is a need for better surface treatment to improve adhesion.

Fig. 1 (a) and (b) show the PPHF treated and untreated PTFE strips at X 80 magnification. The treated PTFE shows microroughness which is essential for good adhesion of the metal. Figs. 1(c) and (d) show for the same samples after electroless plating of copper. While untreated surface shows microroughness with dispersed coating, the treated sample forms a denser deposit with larger grain boundaries indicating formation of clusters. Fig 1(e) and (f) show the SEM for electroplated copper on the treated and untreated PTFE surfaces. The formation of dense clusters with large grain boundaries is clearly seen in the treated sample.

The exact mechanism which leads to the observed behavior is not fully understood. Obviously, the treatment with PPHF produces a local surface modification which in turn produces a substrate with several anchoring points as seen from Fig. 1(a) and (b). The deposit on this surface follows preferred orientation which results in dense clusters. However, on untreated surface the deposition possibly occurs in all orientations as shown by micro rough surface profile observed with SEM. Thus. these results clearly indicate that this treatment results in improved copper deposition on PTFE surface.

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