無

傅學名、傅家啟,鄧志堅

E-mail: 9015757@mail.dyu.edu.tw

ABSTRACT

The morphology and internal structure of the etch pits on the aluminum lithographic plates and their resulting surface properties were investigated for the sake of understanding the pit nucleation and growth during electrograining. Commercial AA1050 plates were electrolytically grained in 35°C nitric and hydrochloric acid electrolytes at 15 A/dm2-50 Hz sinusoidal or square waveforms. The electrograining times varied from 30 to 300 seconds so that pit nucleation and growth could be monitored. The surface morphology of the electrograined aluminum plate was characterized via scanning electron microscopy (SEM). An epoxy replica technique was employed to reveal the detailed internal structure of the etch pits. The microstructure of the etch film was characterized by cross-sectional transmission electron microscopy (TEM). In addition, the composition of the etch film was identified via energy-dispersive spectroscopy (EDS). The as-grained surface of the aluminum plate electrograined in nitric acid was highly convoluted; whereas the as-grained aluminum plate treated in hydrochloric acid exhibited a rather smooth surface, on which was dotted with large craters. The typical pit on the plate electrograined in nitric acid was the hemispherical pit, as illustrated by cross-sectional TEM. Conversely, the aluminum surface after electrograining in hydrochloric mainly comprised of irregular hemispherical pits, which had rather shallow bases, i.e. they are wider than their depth. The etch film structure differed for the different electrolytes employed although the etch film was characterized as amorphous aluminum hydroxide for electrograining in both electrolytes. A porous layered etch film was observed to overlay the hemispherical pits formed in nitric acid. Such a layered etch film is considered to form partly as a result of anodizing at certain anodic potential range and partly as a result of the deposition of aluminum ions as aluminum hydroxide during the negative half cycle. Conversely, the etch pits formed in hydrochloric acid was covered with porous etch film, which was deposited during the negative half cycle. The surfaces of the aluminum plate electrograined in nitric acid comprised of hemispherical pits regardless the ac waveform. However, the population density of the pits formed at square waveform was higher and their size distribution was less uniform. Furthermore, a porous etch product completely filled in the mouth of the layered etch film, which overlaid the individual pits formed in the hydrochloric acid. The basic elements building the surface and their ordering are similar for DC and CC 1050 aluminum plates; that is the one-dimensional and two dimensional coalescence of the individual hemispherical pits form crescent-shaped pits and convoluted pits. However, the progress of pit formation was slower for DC aluminum plate. Consequently, the electrograined DC aluminum plate contained less etch pits and had lower roughness and effective surface area as compared to the CC aluminum plate. The performance and running life of aluminum lithographic plate could be enhanced via proper electrograining treatment. The findings of present study provide a basis for optimizing the electrograining parameters for the aluminum lithographic plate.

Keywords : electrograining ; lithographic printing plates ; hemispherical pits ; cubit pit ; etching ; convoluted pits ; crescent-shaped pits ; etch film

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