Electrograining Behavior of the 1050 Aluminum Plate

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ABSTRACT

英文摘要 This study aims at establishing the "processing-pit morphology-surface properties" relationship of 1050 aluminum sheet used for lithographic printing so that the pit nucleation and growth mechanism can be understood. Two basic electrolytes had been chosen including nitric acid and hydrochloric acid. Main electrograining parameters were current density of 15 A/dm2, frequency of 50 Hz, electrolyte temperature of 35 oC. Typical times for electrograining ranged from 30 to 300 seconds. After removing the etch film in a phosphoric and chromic acid solution, the properties of electrograined surface were measured including the roughness profiles and the capacitance. Detail microstructural characterization was carried out including the surface morphology examination using scanning electron microscopy (SEM) and atomic force microscopy (AFM), the internal structural characterization of etching pits using replica technique, and the detailed microstructural observations using cross-sectional transmission electron microscopy (TEM) specimens. In addition, energy-dispersive spectroscopy (EDS) analysis was used to identify the composition of etch films. Pit nucleation and growth during electrolytic graining is summarized as following: Pits nucleated independently on aluminum surface during the beginning of graining. As graining proceeded, individual pit coalesced laterally to form a convoluted surface at which relatively small pits nucleated. The numbers of pits at convoluted surface reached at a saturated state after a 120-sec. graining when the convoluted surface exhibits a characteristic grape-like morphologh. At the same time, the electrograined surface exhibits an optimal surface roughness and a maximum increase in the surface area. After further electrograining, the pits forming the grape-like structure coalesced laterally to form relatively small convoluted surfaces which in turn evolved into a large pit as electrograining proceeded. Electrolyte composition was found to influence decisively the morphology of grained surface. Chloride ion facilitated the breakage of etch film, resulting in the continuous etching of existing pit during anodic half. On contrary, nitric ion suppressed the nucleation and growth of pit on which the etch film was stabilized due to the presence of nitric ion. Spherical pits were observed on the surface of aluminum sheet electrograined in the nitric acid solution. Meanwhile, the chloride ion in the electrolyte has shown to have detrimental effects on the morphologies and uniformity of etching pits. Lithographic printing method produces high-quality prints and exhibits excellent durability in comparison with other commercialized printing techniques. The resolution of prints is enhanced in case that aluminum sheet is properly electrograined. The findings of this work has gained a better understanding about the electrograining behaviors of 1050 aluminum sheet. The techniques established provide a basis for the development of high-quality aluminum sheet for lithographic printing.

Keywords : lithographic printing plate ; AA1050 ; AA3003 ; electrograining ; cold-rolled structure ; capacitance ; surface roughness ; etch pit ; replica ; etch film ; convoluted surface

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