AC ELECTROGRAINING OF ALUMINUM PLATES USING DIFFERENT CURRENT WAVEFORMS

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ABSTRACT

THE MECHANISMS OF ETCH PIT NUCLEATION AND GROWTH, AND ETCH FILM FORMATION WERE STUDIED VIA THE MICROSTRUCTURAL CHARACTERIZATION AND SURFACE PROPERTY MEASUREMENT ON THE ELECTRO -GRAINED 1050 ALUMINUM LITHOGRAPHIC PRINTING PLATES. SEVERAL PARAMETERS OF AC ELECTROGR -AINING WERE STUDIED, INCLUDING THE FREQUENCY, WAVEFORM, AND THE CHARGE AND DENSITY PEAK RATIO OF ANODIC HALF CYCLE TO CATHODIC HALF CYCLE OF THE AC CURRENT. ONE OF THE TWO SAM -PLES PREPARED AT EACH ELECTROGRAINING BATCH, WAS IMMERSED IN PHOSPHORIC/CHROMIC ACID TO REMOVED THE ETCH FILM SO AS TO MEASURE THE SURFACE ROUGHNESS AND CAPACITANCE OF THE AL P -LATE, AND THE WEIGHT OF DISSOLVED AL AND ETCH FILM. IN ADDITION, THE MORPHOLOGY OF THE ETCH PIT WAS CHARACTERIZED USING SCANNING ELECTRON MICROSCOPY (SEM).THE OTHER SAMPLE WAS RESERVED FOR PLANE-VIEW SEM AND CROSS-SECTIONAL TRANSMISSION ELECTRON MICROSCOPY (TEM) OB SERIATION FOR CHARACTERIZING THE MICROSTRUCTURE AND COMPOSITION OF THE ETCH FILM. WHEN ELECTROGRAINED USING SINUSOIDAL AC CURRENT WITH FREQUENCY OF 1 HZ, THE AL PLATE WA -S DOTTED WITH RELATIVELY LARGE ETCH PITS. CONVERSELY, THE AL PLATE WAS UNIFORMLY GRAINED AT 50 HZ, LEADING TO THE FORMATION OF RELATIVELY FINE ETCH PITS. AS ELECTROGRAINING FREQ -UENCY WAS INCREASED TO 250 HZ, THE AL PLATE WAS NON-UNIFORMLY GRAINED; THAT IS, THE AREA DOTTED WITH STRIPE-LIKE PITS COEXISTED WITH THE AREA THAT REMAINED UNATTACKED.GENERALLY, AS ELECTROGRAINING FREQUENCY INCREASED, THE WEIGHT OF THE DISSOLVED AL AND THE ETCH FILM DECREASED, AND EACH LAYER OF THE LAYERED ETCH FILM BECAME THINNER. ALTHOUGH NO DISCERNIB -LE DIFFERENCE WAS MADE BETWEEN THE SINUSOIDAL AND SQUARE WAVEFORMS AS FOR HOW THE ELECTR -OGRAINING FREQUENCY AFFECTED THE GRAINING BEHAVIORS OF THE AL PLATE,THE STRUCTURE OF THE ETCH FILMS DIFFERED WITH THE CURRENT WAVEFORM.FOR EXAMPLE, THE ETCH FILM EXHIBITED A LAYE -RED STRUCTURE WHEN THE SINUSOIDAL WAVEFORM WAS USED. HOWEVER, THE MOUTH OF THE LAYERED E -TCH FILM FORMED USING THE SQUARE WAVEFORM WAS FURTHER FILLED WITH ETCH PRODUCTS. WITH INCREASING THE CHARGE RATIO OF ANODIC TO CATHODIC HALF CYCLE, THE ETCH PITS FORMED IN NITRIC ACID BECAME BIGGER, RESULTING IN A NON-UNIFORMLY GRAINED SURFACE. THE WEIGHT OF THE DISSOLVED AL INCREASED AND THAT OF THE ETCH FILM DECREASED WITH THE CHARGE RATIO. CONVERSELY, A RELATIVELY THICK SINGLE-LAYERED ETCH FILM FORMED WHEN THE CHARGE RATIO OF CATHODIC TO ANODIC HALF CYCLE WAS INCREASED. WHEN ELECTROGRAINED IN HYDROCHLORIC ACID, THE ATTACK OF THE AL PLATE CHANGED FROM GRAINING TO ETCHING AS THE CHARGE RATIO OF ANODIC TO CATHODIC HALF CYCLE WAS INCREASED, LEADING TO THE FORMATION OF COARSE SQUARE ETCH PITS. RELATIVELY LARGE HEMISPHERICAL PITS WHICH BASES WERE COVERED WITH A THIN ETCH FILM WERE OBSERVED AS THE CHARGE RATIO EXCEEDED 10. SIMILARLY, THE GRAINING CHANGED FROM UNIFORM TO NON-UNIFORM AS THE CHARGE OF THE CATHODIC HALF CYCLE INCREASED. MEANWHILE, THE ETCH FILM DISPLAYED A LAYERED STRUCTURE WITH MICORVOIDS RESIDING ALONG THE LAYER BOUNDARY. IN STEAD OF ELECTROGRAINING, THE AL PLATE DISSOLVED UNIFORMLY INTO THE ELECTROLYTE WHEN D -ECREASING THE CATHODIC DENSITY PEAK WHILE KEPT THE ANODIC DENSITY PEAK CONSTANT.MEANWHIL -E, THE ETCH FILM EXHIBITED A SINGLE LAYERED STRUCTURE,WHICH TENDED TO PEEL OFF THE AL SU -BSTRATE. A THIN OXIDE FILM WAS OBSERVED TO BE ADHERENT TO THE AL SUBSTRATE THAT REMAINED UNATTACKED. CONVERSELY, THE POPULATION DENSITY OF THE HEMISPHERICAL PITS DECREASED WITH DECREASING ANODIC DENSITY PEAK WHILE KEPT THE CATHODIC DENSITY PEAK CONSTANT. MOREOVER, THE ETCH PIT WAS ENTIRELY FILLED WITH ETCH PRODUCT.

Keywords : LITHOGRAPHIC PRINTING, ELECTROGRAINING, ETCH FILM, WEIGHT OF DISSOLVED A

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