Mechanical properties of nickel fabricated by electroplating with supercritical CO_2 emulsion evaluated by micro-compression test using non-tapered micro-sized pillar

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Abstract

This paper reports mechanical properties of nickel films fabricated by high pressure electroplating (HPE) and electroplating with supercritical CO_2 emulsion (ESCE). Structures and mechanical properties of the plated films were examined by TEM, electron backscattered diffraction analysis and micro-compression test using a non-tapered micro-sized pillar. The films were electroplated in an electrolyte composed of Watts bath, supercritical CO_2 and surfactant. Agitation in ESCE leads to the formation of many CO_2-in-water type micelles. The micelles would cause an effect called periodic plating characteristic, and this effect refined the microstructure of the plated nickel from 3 μm of columnar grained structure to 8 nm diameter of equiaxial grained structure. Mechanical properties were also improved to 3.5 GPa of compressive strength, which was five times higher than the HPE nickel. The high strength in ESCE is believed to be largely a result of grain refinement and carbon impurity.

Additional Information

Nagoshi et.al in Tokyo Institute of Technology proposed a novel method for fabrication of micro-pillar without tapering. Mechanical properties and deformation behavior in selected small area can be easily obtained using non-tapered micro-pillar fabricated

with this method. Present paper investigates effect of number of grains in a specimen on mechanical property deviation and concludes that specimen with size at least 30 times larger than size of its microstructures is required for accurate measurement of mechanical properties. We evaluate nanocrystalline nickel using non-tapered micro-pillar fabricated from films electrodeposited (see article here in Advances in Engineering). The non-tapered micrio-pillar fabrication method can be used by any focused ion beam machine with functions of maximum 50 degree tilt and 360 degree rotation. In addition, the micro-sized cantilever specimen proposed by our group has large advantage for measuring individual microstructures such as grain boundary or second phase. In previous reports, we investigate an anisotropic structure in electrodeposited Ni film [H. Imamura et.al, 'Evaluation of anisotropic structure in electrodeposited Ni film using micro-sized cantilever' Microelectronic Engineering 100 (2012) 25-27]