Mechanical properties of nickel fabricated by electroplating with supercritical CO\textsubscript{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\textsubscript{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\textsubscript{2} and surfactant. Agitation in ESCE leads to the formation of many CO\textsubscript{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 \(\mu\)m 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 micro-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
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