Accepted Manuscript

Pulse electrodeposition of copper-manganese alloy in deep eutectic solvent

Wei-Shen Chiang, Jun-Qian Huang, Po-Chun Chen, Pu-Wei Wu, Aniruddha Joi, Yezdi Dordi

PII: S0925-8388(18)30309-8

DOI: 10.1016/j.jallcom.2018.01.301

Reference: JALCOM 44765

To appear in: *Journal of Alloys and Compounds*

Received Date: 11 October 2017

Revised Date: 15 January 2018

Accepted Date: 22 January 2018

Please cite this article as: W.-S. Chiang, J.-Q. Huang, P.-C. Chen, P.-W. Wu, A. Joi, Y. Dordi, Pulse electrodeposition of copper-manganese alloy in deep eutectic solvent, *Journal of Alloys and Compounds* (2018), doi: 10.1016/j.jallcom.2018.01.301.

Pulse electrodeposition of copper-manganese alloy in deep eutectic solvent

Wei-Shen Chiang[a], Jun-Qian Huang[b], Po-Chun Chen[b,*], Pu-Wei Wu[a,*]

Aniruddha Joi[c], Yezdi Dordi[c]

[a]Department of Materials Science and Engineering, National Chiao Tung University

Hsinchu 30010, Taiwan, ROC

[b]Institute of Materials Science and Engineering, National Taipei University of Technology

Taipei 10608, Taiwan, ROC

[c]Lam Research Corp., Fremont, CA 94538 USA

Abstract

Copper-manganese alloy has been established to improve resistance toward electromigration for interconnects. In this work, we employ a deep eutectic solvent (DES) to formulate a nonaqueous electrolyte for pulse current electrodeposition of Cu-Mn alloyed film. Using impedance spectroscopy to record ionic conductivities of DES-based electrolytes, we determine the optimized bath with a Cu/Mn molar ratio of 1:20. We produce an uniform, smooth, and composition-controllable CuMn alloyed film after exploring various pulsing parameters. Signals from X-ray diffractometer (XRD) suggest successful alloying of Cu and Mn with minor presence of MnO_2. Profiles from X-ray photoelectron spectroscopy (XPS) validate the metallic nature of Mn from the as-deposited film. Upon Ar annealing, both XRD and XPS exhibit strong signals of MnO_2 formation. In addition, images from transmission electron microscope and qualitative elemental chemical mapping indicate Mn atoms in CuMn alloy either diffuse through the underlying Cu seed layer and segregate at the Cu/SiO_2 interface, or migrate toward the external surface forming MnO_2.

Keywords: Cu-Mn alloy; Deep eutectic solvent; Pulse electrodeposition; Diffusion barrier

* Corresponding authors.

Tel.: +886 2 27712171; fax: +886 2 27317185.

E-mail address: cpc@mail.ntut.edu.tw (P.-C. Chen).

Tel.: +886 3 5131227; fax: +886 3 5724727.

E-mail address: ppwu@mail.nctu.edu.tw (P.-W. Wu).