Fall 10-5-2015

Orientation-depedent mechanical behaviour of electrodeposited copper with nanoscale twins

Maxime Mieszala
EMPA, maxime.mieszala@empa.ch

Guillonneau Gayrlord
Ecole Centrale de Lyon

Jeffrey Wheeler
EMPA

Rejin Raghavan
Max Planck Institut fur Eisenforschung

Madoka Hasegawa
EMPA

See next page for additional authors

Recommended Citation

1 M. Dao, L. Lu, Y.F. Shen, and S. Suresh, Acta Mater. 54, 5421 (2006). 2 M. Hasegawa, M. Mieszala, Y. Zhang, R. Erni, J. Michler, and L. Philippe, Electrochem. Acta (2015), Accepted for publication, doi:10.1016/j.electacta.2015.08.022

Authors
Maxime Mieszala, Guillonneau Gayrlord, Jeffrey Wheeler, Rejin Raghavan, Madoka Hasegawa, Johann Michler, and Laetitia Phillippe

ORIENTATION-DEPENDENT MECHANICAL BEHAVIOUR OF ELECTRODEPOSITED COPPER WITH NANOSCALE TWINS

Maxime Mieszala, Empa – Swiss Federal Laboratories for Materials Science and Technology, Switzerland
maxime.mieszala@empa.ch
Guillonneau Gaylord, Ecole Centrale de Lyon, Université de Lyon, Laboratoire de Tribologie et Dynamique des Systèmes, UMR 5513 CNRS/ECL/ENISE, France
Jeffrey M. Wheeler, Empa – Swiss Federal Laboratories for Materials Science and Technology, Switzerland, ETH Zurich, Switzerland
Rejin Raghavan, Max-Planck-Institut für Eisenforschung GmbH, Düsseldorf, Germany
Madoka Hasegawa, Empa – Swiss Federal Laboratories for Materials Science and Technology, Switzerland
Stefano Mischler, Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland
Johann Michler, Empa – Swiss Federal Laboratories for Materials Science and Technology, Switzerland
Laetitia Philippe, Empa – Swiss Federal Laboratories for Materials Science and Technology, Switzerland

Key Words: twin boundary engineering, Nanotwinned Cu, microcompression

The electrodeposition of copper is an important technology for the fabrication of micro-components and interconnects. In contrast to nanocrystalline copper, nanotwinned Cu (nt-Cu) exhibits remarkable strength, ductility and electrical conductivity[1]. Our recent work[2] reported the possibility to deposit copper samples with highly-oriented nanoscale twins by pulse electrodeposition. The twin orientation was altered from horizontal to vertical by changing the applied potential and the twin spacing was controlled with pulse-off time.

In this poster, we report the orientation-dependent mechanical properties of electrodeposited copper with nanoscale twins confined within micron-sized columnar grains. The strength and strain rate sensitivity are investigated with respect to the twin orientation by micro-pillar compression. A strong anisotropy is observed between both orientations. A higher strength and strain rate sensitivity is measured for micro-pillars with horizontal twins when compared to vertical twins. Mechanisms responsible for this effect are explored through post-deformation SEM and FIB imaging. The plastic anisotropy was related to the change in critical resolved shear stress in twinned slip system. The experimental work shows the possibility to tailor the mechanical properties of nt-Cu by grain boundary engineering.

[1] M. Dao, L. Lu, Y.F. Shen, and S. Suresh, Acta Mater. **54**, 5421 (2006).
[2] M. Hasegawa, M. Mieszala, Y. Zhang, R. Erni, J. Michler, and L. Philippe, Electrochem. Acta (2015), Accepted for publication, doi:10.1016/j.electacta.2015.08.022.

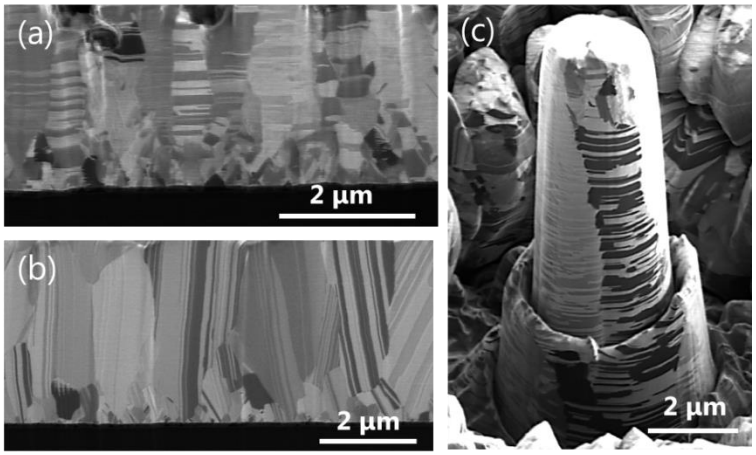

Figure 1 – Cross-section images (a) (111)-textured and (b) (112)-textured copper films. (c) FIB micrograph of a micropillar.