High Electromigration lifetime of Nanotwinned Cu Used in Redistribution Layers of Fan-out

I-Hsin Tseng and Chih Chen
Department of Materials Science and Engineering, National Chiao Tung University
chih@mail.nctu.edu.tw

Abstract

In Fan-out package, the line width of redistribution layers (RDLs) decreases continuously. Therefore, the RDLs are under larger current density than before. In previous research, there are several methods to enhance electromigration lifetime, such as doping a few percent of metal atoms in Cu, adding a thin layer of metal layer at the top of RDLs to increase the adhesion of Cu surface and change the microstructure of Cu to increase the mechanical strength of RDLs. In this study, we aim to find a solution to enhance the electromigration resistance in RDLs. Therefore nanotwinned Cu (nt-Cu) was adopted as RDLs.

We prepared two different samples. One condition was highly <111>-oriented nt-Cu films fabricated via DC electroplating. The electroplating solution was a high-purity CuSO4 solution with additives for the growth of nanotwins. The electroplating conditions are a current density of 8 ASD under room temperature. The second condition was regular Cu film with no preferred orientation as the control sample. The regular Cu is fabricated with a commercial solution in the industry. The current density was set to 2 ASD at room temperature. We electroplated copper films on the wafer with a 100 nm thick TiW barrier layer followed by a 200 nm thick <111> preferred oriented Cu seed layer. The wafer used has photoresist pattern. A 800 μm long copper line with pads was fabricated. The line width is 10 μm and the line height is 5 μm. After electroplating, low curing temperature PI was coated on copper films and cured at 230°C in a furnace for one hour. The thickness of PI coating was approximately 3 μm. After the fabrication of samples, the samples underwent electromigration tests.

We compared the electromigration lifetime of nanotwinned Cu (nt-Cu) and regular Cu with polyimide capping. The microstructure changes of both two samples were observed by focused ion beam. The results show that the electromigration lifetime of nt-Cu lines is 4 times higher than regular Cu lines.