Electromigration void suppression in nanoscale copper and silver conductors

A. Zehe¹, A. Ramírez².
¹Universidad Autónoma de Puebla, ²Instituto de Ciencias ICUAP, Ciudad Universitaria, Apartado Postal 1505, 72000 Puebla, Pue., México, e-mail: aramirs@siu.buap.mx

Abstract
The down-scaling of feature sizes in micro-electronic devices has led to extremely high current densities in metallic IC-interconnects of almost 10 MA. Electromigration phenomena turn out to be a major concern for failures by conductor interruption due to void formation, or short circuits due to hillock growth. The high current densities have brought aluminium, mainly used in IC-wiring, to physical borders of allowable power dissipation and tolerable activation energies for mass transport. The need for new conductor materials in deep sub-micron dimensions signals one of the most important changes in materials technology, that the semiconductor industry has experienced since its very beginnings. Copper with its inherent properties of low electrical resistance became the metal of interest with the potential to meet the challenges of the 130 and 100 nm technologies. Yet the investigation of replacements for Cu is already under way, be it alloy improvements for Cu or even a different metal. From the conductivity point of view silver is the best known metallic conductor under normal conditions and would surpass copper by 4% (which is far less than the 40% which copper gains relative to aluminium). Alloying is often found to improve electromigration resistance. In the present paper we present atomic-based selection rules for solute elements in copper and silver. In the framework of the present study dilute copper alloys hold an advantage over silver.