Low Temperature Atomic Layer Deposited MoN_x as an Efficient Cu-diffusion Barrier

Tae Hyun Kim, Dip K. Nandi, and Soo –Hyun Kim*

School of Materials Science and Engineering, Yeugnam University, Gyeongsangbuk-do 712-749, Republic of Korea

A deposition technique with extremely precise control over film thickness, the low deposition temperature and non-corrosive by products (like acids) during deposition are the essential criteria for an efficient barrier layer. To address all of these issues, molybdenum nitride (MoN_x) is deposited at a relatively low temperature (175-300^oC) by atomic layer deposition (ALD) using molybdenum hexacarbonyl [$Mo(CO)_6$] as a novel precursor for Mo and ammonia gas (NH_3) as reactant. The as-grown MoN_x are mostly amorphous, however poor nano-crystalline *h*-MoN phase formation is evident from the deposition temperature of 250 ^oC and beyond. The lowest resistivity less than 6000 μΩ-cm for as-deposited film reflects the suitable properties of these MoN_x films to be used as barrier material. Nevertheless, X-ray diffraction (XRD) analysis also reveals that the crystallinity could be enhanced by post-annealing from 500 ^oC to 700^oC that converts the film into cubic-Mo_2N phase as well. Corresponding with this, the film resistivity was decreased to ~4000 μΩ-cm. The properties of as-deposited and annealed films are further well-characterized by secondary-ion mass spectroscopy (SIMS), X-ray photo electron spectroscopy (XPS), Rutherford back-scattered spectroscopy (RBS) etc. Two set of ALD-MoN_x films (~4 nm) grown at 225 and 275 ^oC are tested as a diffusion layer against Cu. It is observed that the film deposited at higher temperature acts better for this purpose. The possible reason for this might be the higher density of the ALD-MoN_x films grown at 275^oC compared to the films deposited at 225^oC.

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*Corresponding author: soohyun@ynu.ac.kr