Area Selective ALD
Room On Demand - Session AS4
Area Selective ALD Poster Session

AS4-1 Effect of Surface Cleaning Efficacy on Vapor-Phase Cleaning of Cu and Co Using Anhydrous N_2H_4

***Su Min Hwang**, J. Kim, D. Le, R. Gummadavelly, Y. Jung, J. Veyan,* University of Texas at Dallas, USA*; D. Alvarez, J. Spiegelman,* RASIRC*; J. Kim,* University of Texas at Dallas, USA

As the critical dimension of current Copper (Cu) metal line shrinks below 5 nm, the resistivity of Cu is expected to increase drastically, due to electron scattering at the sidewall and grain boundaries.[1] In addition, the high-resistivity liner and diffusion barrier, currently required in the copper interconnects, attribute to the decrease of effective width of Cu. To circumvent this issue, the study of alternative materials to Cu have been reported. Among the various metals, Cobalt (Co) has been proposed as a potential material with comparable resistivity below 7 nm thickness.[2] Several processes on ALD of Co have been reported requiring an additional reduction step to obtain metallic Co. Therefore, it is imperative to explore reducing agents capable of reducing the oxide on Co at low temperatures. Recently, hydrazine (N_2H_4) has been reported as the reducing agent of the Cu oxide due to its higher reduction capability.[3] Inspired by hydrazine's unique characteristics, we explore the feasibility of vapor-phase reduction of Co oxide using N_2H_4 to achieve an ideal metallic Co film in an ALD environment. Additionally, a detailed reduction mechanism of the Co oxide by comparing with Cu oxide will be studied using *in-situ* surface analysis. In this study, we have demonstrated the effect of vapor-phase cleaning on Cu and Co using anhydrous N_2H_4 with its high reduction capability to remove surface contaminants and metal oxide. The Cu film with 1.5 µm thickness and the Co film with 200 nm thickness were deposited on a silicon substrate using electroplating and sputtering, respectively. The preparedCu and Co films were treated with ALD-like multiple exposures of N_2H_4 in the temperature range of 100 – 400 °C. Each cycle consisted of 0.5 s N_2H_4 exposure and 120 s Ar purge. The XPS analysis of the Cu samples treated at 200 ^oC show a significant amount of copper oxide was reduced to metallic copper with an approximate thickness of 1 nm. Meanwhile, the Co samples show the cleaning efficacy at above 350 ^oC due to the relative stability of the cobalt oxide. In addition, *in-situ* reflection absorption infrared spectroscopy (RAIRS) was employed to elucidate the individual surface chemistry of Cu and Co films during the N_2H_4 exposure step. The detailed experimental results will be presented.

We thank Rasirc Inc. for funding this project and providing the Brute N_2H_4.

[1] P. Kapur, et al., IEEE Trans. Electron Devices **49**, 590 (2002).

[2] M.F.J. Vos et al., J. Phys. Chem. C **122**, 22519 (2018).

[3] S.M. Hwang, et al., ECS Trans. **92**, 265 (2019).

Author Index

Bold page numbers indicate presenter