Molecular Self-assembly of Direct Plate Cu Diffusion Barriers

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The use of copper deposited by electrochemical deposition (ECD) in current interconnect metallization requires the use of a tri-layer stack to prevent the Cu from diffusing into the substrate and enable the ECD process. The traditional barrier seed stack is composed of Cu/Ta/TaN deposited by physical vapor deposition (PVD). The goal of this stack is to enable the ECD process, promote adhesion between the Cu and the TaN, and prevent Cu diffusion[1]. As interconnect line widths continue to shrink, scaling this stack is becoming more difficult, resulting in increased line resistance and reliability concerns[2]. This is making the idea of transitioning from the traditional liner/seed stack to a single layer that could function as a diffusion barrier, adhesion promoter, and a directly platable surface increasingly attractive to improve the extendibility of copper interconnect technology. Prior research into mixed phase materials has shown that they can perform as direct plate Cu diffusion barriers but are only scalable to thicknesses of 2-3 nm[3]. In scaling beyond the 2 nm limit self-assembled monolayers are one potential alternative.

This presentation will cover the details of research into using self-assembled monolayers (SAM) deposited by chemical vapor deposition (CVD) as a method of producing direct plate Cu diffusion barriers. The SAMs used in this work are functionalized propyl chains, and the assembly and performance analysis of these films will be discussed. Figure 1 shows ECD Cu deposited on 15 nm ALD Cu on amine terminated SAM.

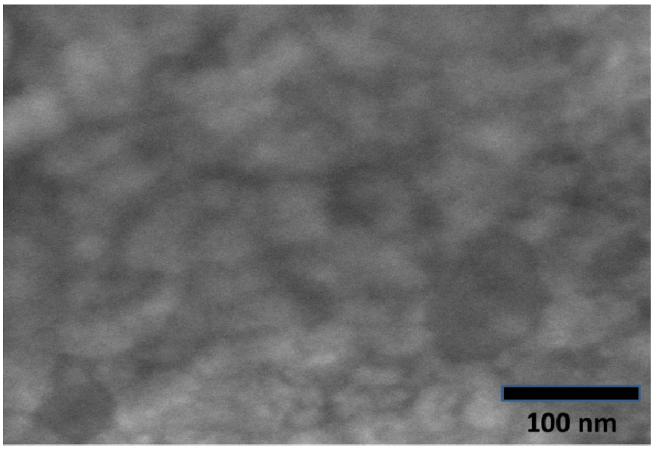

Fig. 1 Direct plating of Cu on 15 nm ALD Cu on amine terminated SAM.

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[1] C. Chang and C. Hu, *Applied Physics Letters*, **57**, 617 (1990).

[2] R. Rosenberg, D. Edelstein, C. Hu, and K Rodbell, *Annual Review Materials Science*, **30**, 229 (2000).

[3] D. Greenslit and E. Eisenbraun, *Electrochemical Society Transactions*, **35** (20), 17 (2011).