Electromigration-Induced Modifications in Cr/Ni Bilayer Microbridges

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Electromigration (EM) is a critical reliability concern in microelectronic interconnects, where high current densities drive atomic diffusion, inducing structural and electrical modifications [1]. However, recent studies have also explored EM as a controlled method for nanofabrication, enabling localized structural and electronic modifications in microstructures [2]. In this work, we investigate the EM-driven modifications in Cr/Ni bilayer microbridges fabricated on Si/SiO_2 substrates. These microbridges, consisting of a 5-nm Cr adhesion layer underneath a 25-nm Ni layer, were subjected to a controlled pulsed current protocol, with resistance monitoring before, during, and after each pulse to track the progression of electromigration. Resistance evolution indicated structural and morphological changes at the microstructural level, particularly in regions of high current density. Surface characterization via Scanning Electron Microscopy (SEM) and Magnetic Force Microscopy (MFM) revealed localized alterations near the constriction edges, suggesting current-driven atomic rearrangement and stress redistribution. MFM analysis indicates potential modifications in domain structures, which could result from strain-induced changes or local oxidation effects. These observations suggest that the Cr layer, initially serving as an adhesion layer, may influence oxidation pathways and potentially interact with Ni under electromigration conditions [3]. Notably, similar interfacial effects have been observed in Ni-based multilayers, where Cr interactions influence oxidation resistance. The observed resistance evolution and morphological changes further suggest localized electroannealing effects, warranting high-resolution structural and chemical analysis to probe potential grain boundary modifications and Ni-Cr interdiffusion. This study provides insight into EM-induced modifications in Cr/Ni systems, with implications for the reliability of microelectronic interconnects applications. Future investigations will focus on advanced characterization techniques to further explore oxidation states, grain boundary dynamics, and potential Ni-Cr interdiffusion under high-current conditions.

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