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STRESS, MICROSTRUCTURE AND STRUCTURAL EVOLUTION IN ANNEALED Si/Al AND Al/Si BILAYERS

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Si(150 nm, amorphous)/Al(50 nm, crystalline; (111) textured) and Al(100 nm, crystalline; (111) textured)/Si(150 nm, amorphous) bilayers were magnetron sputter deposited onto smooth Si(510) substrates and isothermally annealed at 250°C for 60 min in vacuum of 2.10×10^{-6} Torr. X-ray diffraction (XRD), Auger electron spectroscopy (AES) and focused-ion-beam microscopy (FIB) analyses indicated that, for both the annealed Si/Al and the annealed Al/Si bilayers, and as compared to their initial states, the Al (111) texture had become stronger, and that the Al crystallites had grown laterally. The amorphous Si layers had crystallized into random nanocrystals (with a crystallite size of about 10 nm) and were subjected to tensile stress parallel to the film surface. For the Si(150 nm)/Al(50 nm) bilayer in which the Si layer is on top, most of the Si and Al layers had exchanged after annealing: a Si (55 at. %)+Al(45 at. %) mixture (50 nm) on top and a Si(80 at. %)+Al(20 at. %) mixture (150 nm) adjacent to the substrate had formed. Upon annealing, the stress parallel to the surface of the Al layer changed from compressive (-139 MPa) to tensile (+182 MPa), and the microstrain in the Al layer relaxed. For the Al(100 nm)/Si(150 nm) bilayer where Al is on top, only “normal” inter-difusion of the Al and Si layers took place. The tensile stress of the Al layer increased from +27 MPa to +232 MPa upon annealing; the microstrain of the Al layer did not relax in this case. Further, the tensile stress of the crystallized Si layer in the Al/Si bilayer (+578 MPa) is about twice that of the Si layer in the Si/Al bilayer (+209 MPa). The relation between the compositional changes and the stress changes was discussed.

Key words: Si/Al and Al/Si bilayers, inter-diffusion, stress and microstructure evolution.

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