Development of in-plane texture in Cu thin films by post deposition ion beam treatment

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Abstract

Without grain boundaries and triple junctions (scattering centers for electron transportation and points of flux divergence), interconnects made of single crystal metals are expected to show better performance and higher reliability. However, the direct processing of single crystal materials is unattractive due to prohibitive costs. This work presents a cost effective method capable of producing single crystal-like (biaxially textured) thin metallic films with the help of low energy ion bombardment (ion energy is in the keV range). The method started from a seed layer of 50 nm thick Cu film, deposited by magnetron sputtering, with strong (111) fiber texture. This seed layer was then bombarded with parallel 1.2 KeV Ar+ beams. The ion source was installed with an offset angle of 35◦ to the sample surface normal. This corresponds to the $< 110>$ channeling orientation in fcc materials. During ion bombardment, grains were effectively sputtered away except those satisfying channeling condition. The remaining grain islands served as nucleation seeds for the following re-deposition of same material. By repeating the cycle of selective sputtering and subsequent re-deposition, single crystal-like Cu films with both pronounced (111) out-of-plane and in-plane texture were achieved. In addition, the quality (extent of spreading) of in-plane texture was founded to be improved by increasing the number of repeating cycles. Another possible method based on high energy ion bombardment (ion energy is in the MeV range) is still under investigation. This method is expected to be able to enhance the in-plane texture development by ion-induced selective grain growth, which is driven by the volume energy difference between grains satisfying channeling condition and those with random orientation.

Keywords: selective sputtering, in plane texture, channeling

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