Chemical and Structural Investigation of Self-Forming Diffusion Barrier Layers Using Grazing Incidence X-Ray Fluorescence Spectroscopy at Beamline L.

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Within the microelectronics industry, the requirement for reducing device dimensions for increased circuit performance and lower manufacturing costs has led to many avenues of research in advanced materials and fabrication processes. Our research is focused on the investigation of barrier materials for copper interconnect technology. For future sub-32 nm node technology, these films/interfaces need to be made ultra-thin (2-4 nm) and be conformal, which cannot be delivered by conventional deposition techniques. In addition, present day barrier materials may not be suitable when they become ultra-thin. Self-forming diffusion barriers (SFBs), consisting of a Cu-Mn alloy, have recently attracted great interest because they seem to demonstrate good barrier qualities and be compatible with future technology nodes [1-4]. We have previously fabricated and determined the chemical composition of Cu-Mn SFBs on SiO_2 and low-k dielectrics using x-ray fluorescence spectroscopy[4]. At Beamline L at DORIS III, we have used grazing incidence XANES spectroscopy to determine the formation and composition of SFBs through a thin (1-10nm) Cu interlayer. We have confirmed that these SFBs can be formed at anneal temperatures of only 250°C (1 hour anneals), which is important because an interlaying Cu film is a necessary prerequisite if this technology is to be used in future microelectronics fabrication processes.

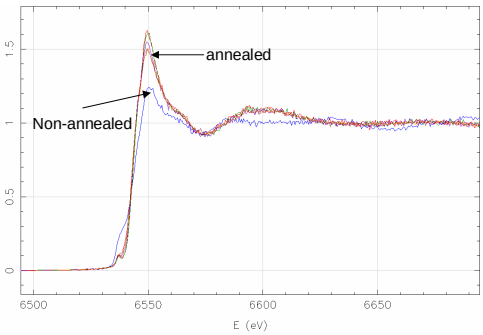

Figure 1: Mn K-edge XANES fluorescence spectra showing successful SFB barrier formation through a 10nm Cu interlayer film. The lowest anneal temperature was 250°C with a duration of 1 hour.

References

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