Angle-Resolved HAXPES analysis of Al_xO_y and Cu_xO_y layers formed by metal salt diffusion into a poly 2-vinylpyridine (P2vP) polymer layer

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This work is motivated by the desire to develop a semiconductor device patterning technology based on precursor infiltration into block copolymer materials. Developing an understanding of the preferential infiltration of metal precursors into one of the polymer blocks is of critical importance to advance this patterning approach. In this study, metal salts were used as a means to diffuse metal ions into poly 2-vinylpyridine (P2VP) polymer brush layers (~4 nm), which had been deposited by spin coating onto silicon substrates. Thin P2VP films infused with aluminum nitrate and copper nitrate by a wet chemical process were analyzed with angle resolved hard x-ray photoelectron spectroscopy (AR HAXPES). This photoemission based technique gives a lot information about a variety of core levels.[1] The large sampling depth of HAXPES measurements (20-30nm) enabled details of the chemical composition of the thin film to be characterized and subsequent angle-resolved HAXPES measurements offered a robust analysis of the interfaces and discrete layers that are present in the films. These measurements displayed evidence of bonding interactions between the elements in the polymer film and the infiltrated salts (see Figure 1) which assists in developing an understanding of the infiltration process which needs to be optimized for device fabrication applications.[2]

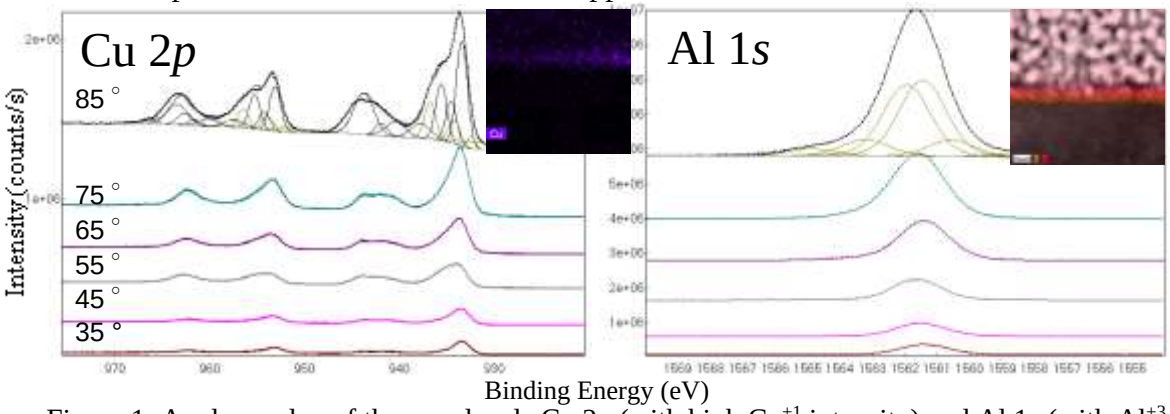

Figure 1: Angle resolve of the core levels Cu 2p (with high Cu^{+1} intensity) and Al 1s (with Al^{+3} signal comparable with Si^{+4}) show that the metal salts were diffused into P2VP. The insert shows the presence of each metal respectively in EDX mapping by TEM.

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[1] P. G. Mani-Gonzalez, M. O. Vazquez-Lepe, F. Espinosa-Magaña, and A. Herrera-Gomez J. Vac. Sci. Technol., A 31, 010601 (2013).

[2] C. Cummins and M. A. Morris. Using block copolymers as infiltration sites for development of future nanoelectronic devices: Achievements, barriers, and opportunities. Microelectron Eng., 195:74–85, 2018.