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Interfacial design of hybrid nanomaterials for advanced joining technologies

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Abstract: With the continuing miniaturisation of micro-electronic devices and sensing components, the typical dimensions of interconnections and integrated components have crossed the micro-scale and entered the nano-scale. Hence, key technologies in the fields of e.g. microelectronics, sensing devices and medical implants have an urgent need for novel joining concepts to integrate, package and assemble dissimilar and heat-sensitive materials with a precision down to the nano-scale (or even the atomic scale). As a result, the field of nanojoining is rapidly evolving and expected to become an enabling technology for the large-scale production and broad application of advanced nanotechnologies in the coming decades [1-3].

This talk addresses recent progress in the design and application of nanostructured materials for emerging nanojoining applications. The latest experimental findings and model predictions on the phase stability of nano-confined metals (and alloys) in a nanomultilayered (NML) configuration during heating will be highlighted (see Figure and Refs. [1-3]). It follows that the NML design (e.g. interface coherency, layer thickness, layer sequence, residual stress state, composition) can be tuned such to invoke fast directional mass transport of the nano-confined metal to the surface at temperatures much below the bulk melting temperature. These findings might open new routes for benign bonding of micro- and nano-scaled systems at ever-lower temperatures.

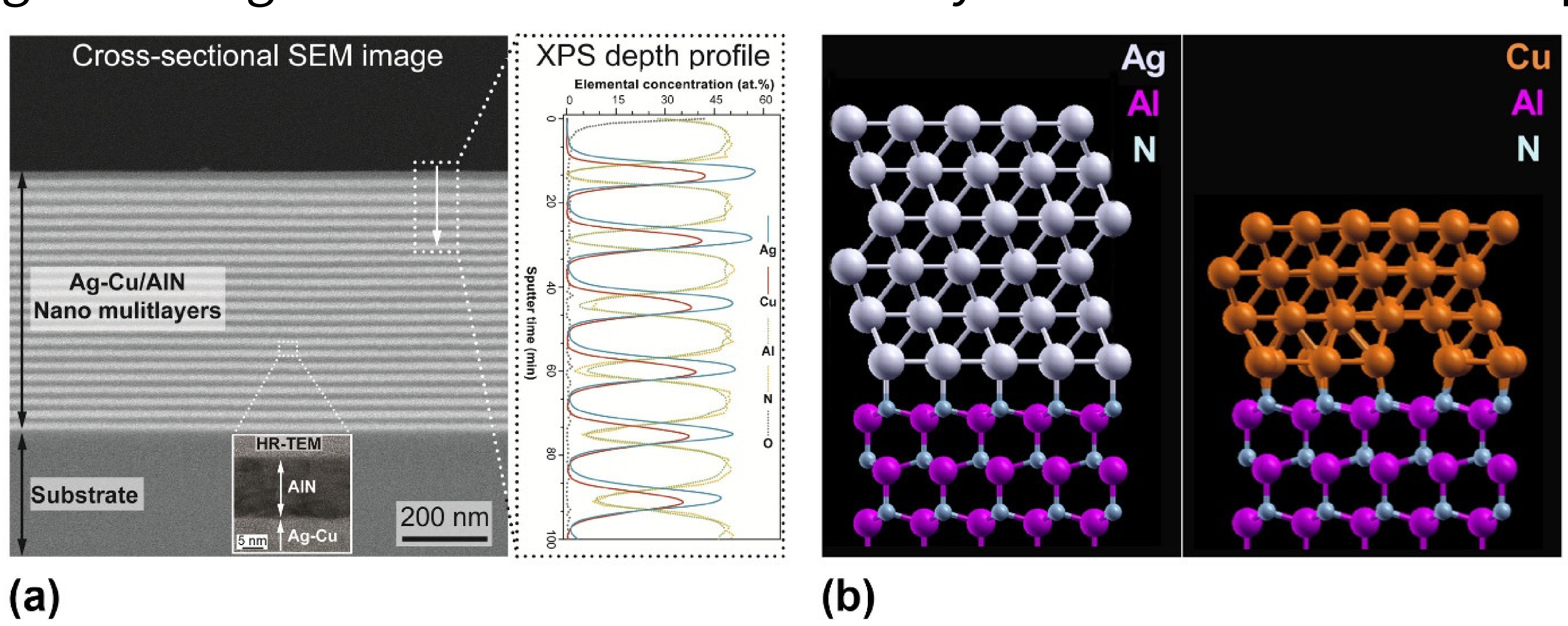

Fig. 1. (a) Cross-sectional secondary electron image and corresponding XPS composition-depth profile of an as-grown AgCu/AlN NML, as constituted of alternating nano-layers (thickness < 10 nm) of a metal or alloy (e.g. Ag, Cu, Ag-Cu) and a chemically inert barrier material (e.g. carbon, nitride, oxide, refractory metal) (light grey: Ag-Cu, dark grey: AlN) [2]. (b) DFT model predictions of the Ag/AlN and Cu/AlN interface structures in the AgCu/AlN NML [2, 3].

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