Nanointerfaces-Driven Frugal Engineering

Need for flexible/wearable electronics, post-CMOS electronics, or ultra-miniaturization of hybrid microelectronics, call for low temperature and autonomous (self-assembly) fabrication with concomitant need for energy efficiency during and post manufacturing. We couple fundamental surface thermodynamics and bottom-up self-assembly to design material synthesis and processing approaches that can meet these demands. This talk discusses the nature of metal nanointerfaces (<10 nm) and how felicitous choice of processing conditions can lead to surface/interface-driven tuning of the thermodynamic energy landscape of the material. This altered landscape enables frugal low energy manipulation of the material by driving relaxation or reactions via low energy pathways. Surface-directed navigation of the energy landscape manifests as metastable states (specifically undercooling), surface composition inversion (chameleon and hedgehog-like surfaces), inside-out (inverted) thermal degradation to create graphene/graphene oxide macrotubes, and surface plasticity or amphiphobicity for size-controlled feature formation or wetting. We will discuss how these breakthroughs are enabling; i) advances in micro- or printed-electronics manufacturing, ii) synthesis of high aspect-ratio synths of electronic materials through ad infinitum polymerization, and iii) translation of these hybrid electronic materials synths into self-assembled diodes and gates. Briefly, we’ll demonstrate how these principles in surface/interface engineering can be expanded to other areas like controlled wetting and solid lubricants.

BIOGRAPHY

Martin Thuo is a professor in the Department of Materials Science & Engineering at North Carolina State University. He has expertise in engineering nanointerfaces and surfaces to significantly alter the thermodynamic energy landscape of a material, leading to unprecedented uses, processing, or relaxation pathways. Thuo has pioneered a set of frugal processing methods that have led to heat-free and low-temperature solders, printed conformal metallic wires on biological tissues, bottom-up multiscale/hierarchical materials for microelectronics, and frugal approaches to rare-earth/precious metal recycling and upcycling. In tribology, and in partnership with local industry, he has developed bio-derived solid lubricants for use at ambient and elevated temperatures. Thuo’s work has been recognized by C&EN as a materials chemistry development of the year, by IDTechEx with a technical development of the year award in Printed electronics, and has been feature across various platforms including Forbes, nature news, C&EN among others. Thuo is an advisory board member for Angewandte Chemie, rising star board member for ACS Nano, and an international advisory board member for Africa Materials research Society (AMRS). He is a co-host and co-organizer of the ICANX talks. Select honors include Mary-Fieser fellowship (Harvard University), ACSnano rising star, Research excellence award (Iowa State), Black & Veatch faculty fellowship, Visiting professorship (3SR and G2E labs, Grenoble), among others. He is also a co-founder of several start-ups.