"Designing Materials Precursors for the Deposition Technique: CVD vs. SPMCSD vs. EBID"

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Abstract:

Precursors for electron beam induced deposition (EBID) are often chosen from compounds developed for chemical vapor deposition (CVD), due to the ready commercial availability of CVD precursors. However, many CVD precursors are unsuitable for EBID because their chemical decomposition mechanisms are different under the two sets of conditions. A common result is EBID deposits of low purity due to incorporation of impurities from ligand fragments. Mechanism-based design of precursors for CVD and surface plasmon mediated chemical solution deposition (SPMCSD) will be presented in case studies for contrast with strategies for design of EBID precursors.

The example for CVD will be deposition of tungsten carbonitride (WN_xC_y), a candidate material for diffusion barriers in Cu metallization schemes for integrated circuits. Deposition temperature is critical for this application and by studying the decomposition mechanism and designing appropriate precursors, we were able to lower the temperature for growth from a single source precursor from 450 to 125 °C. In SPMCSD, the critical features of a precursor are its optical properties and a decomposition temperature matched with the hot spots generated by surface plasmon resonance (SPR). By careful precursor choice, we were able to grow Au nanoparticles from CH_3AuPPh_3 upon excitation of the SPR of a Ag film on nanosphere (AgFON) substrate by irradiation with visible light. In contrast, EBID involves surface reactions under high electron flux, necessitating different precursor design rules. Strategies for adapting selected CVD precursor types for EBID and efforts to identify privileged ligands and optimal coordination spheres for precursors will be discussed in the context of new precursors for EBID of Ru, Pt and bimetallic alloys.

Biosketch:

Lisa McElwee-White is the Colonel Allen R. and Margaret G. Crow Professor of Chemistry at the University of Florida. She received a B.S. degree from the University of Kansas and completed her Ph.D. at the California Institute of Technology. After two years of postdoctoral work at Stanford University, she joined the Stanford faculty as an Assistant Professor in 1985. She moved to the University of Florida as an Associate Professor in 1993 and was promoted to Professor in 1997. Following a term as Associate Dean for Administrative Affairs in the College of Liberal Arts and Sciences, she returned to full time research and teaching. She serves as director of the UF Beckman Scholars Program and recently served as the Director of the NSF-CCI Center for Nanostructured Electronic Materials. Prof. McElwee-White's research interests center around the applications of organometallic chemistry in materials science. Her work has been funded by a variety of federal agencies, foundations, and companies including NSF, DOE, ARO, ONR, NASA,

ACS-PRF, the Beckman Foundation, HHMI and FEI. She is the author of 138 refereed publications and has presented 182 invited lectures. Her Editorial Board service includes *Organometallics*, the *Journal of Organic Chemistry, Letters in Organic Chemistry* and *Current Organic Chemistry.* She has recently served as Chair of the Division of Organic Chemistry of the American Chemical Society and was named as a Fellow of the American Chemical Society in 2010. Her recent awards include the Florida Award (2015) and the Charles H. Stone Award (2012).