Development of Precursor Inks for Electronic Materials Deposition

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Abstract

Thin film semiconductors, metals and insulators constitute the basic building blocks for a wide range of devices including solar cells, flat panel displays, sensors and a variety of electro-optical devices. Conventionally these devices have been made up from a variety of PVD deposited layers and photolithographic patterning steps in sequence. This approach is both capital and time intensive and uses materials inefficiently. The need to lower the cost and increase the scale and market penetration of these devices has stimulated an examination of low-cost deposition and patterning approaches. NREL has focused on the development of ink-based technologies coupled with rapid thermal processing and laser processing as an alternative to conventional microelectronics processing. Deposition of thin films using liquid precursor inks offers an attractive alternative to the traditional vacuum-based approaches. The key is the development of precursors that are stable and easy to handle and that decompose under reasonable conditions to give the desired material. We have developed a flexible approach to ink development that involves the use of metal organic decomposition (MOD) complexes and nanoparticles as precursors for deposition of materials. Using this approach, semiconductor and oxide films have been deposited using both nanoparticle and MOD inks, and inks for printing metals and conducting polymers have been developed. Ink formulations and the advantages of liquid precursors will be discussed and illustrated using examples of semiconductor and metal deposition. We will also briefly assess the state of the art for ink jet printing (the preferred deposition tool) for this technology where an increasing commercial interest in printing electronic materials has driven the development of higher resolution, higher through-put tools.

Author Biography

Calvin Curtis holds a B.S. in chemistry from Harvey Mudd College and a Ph.D. in inorganic chemistry from the University of California at Berkeley. He has been employed as a research scientist at the National Renewable Energy Laboratory for 26 years. His research interests include materials science related to photovoltaics and hydrogen storage, inkjet printing of functional materials and homogenous catalysis.