# Cation Size Effects In Solution-Processed Thin-Film Oxide Transistors

Jeremy Smith

Recently metal oxide semiconductors and conductors have become serious candidates for use in thin-film electronics with applications ranging from display backplanes, to unconventional solar cells, to disposable radio-frequency identification tags. There is a driving force to develop materials with improved electrical properties over current technologies, as well as to develop strategies to process such materials at low-cost on large-area, flexible substrates. Amorphous metal oxides, such as those based on indium or zinc oxide, combine high electron mobilities, excellent transparency in the visible, solution-processability, and mechanical robustness. Vapour deposition of these materials, such as by sputtering, is common with In-Ga-Zn-O being the most interesting and mature technologically, as its use in the next generation iPads highlights. Solution deposition on the other hand still requires investigation to obtain reliable, high-performance oxides.

In the Marks group we have developed a general method for reducing the processing temperature required during sol-gel type oxide film formation by using "combustion" synthesis. We have applied this to several oxides including indium oxide, In-Sn-O, In-Zn-O, and In-Ga-Zn-O, all annealed at temperatures less than 300˚C. Not only is such a method technologically advantageous by enabling the use of plastic substrate, but it also allows us to systematically study the structural and electronic properties of amorphous oxides over a wide compositional phase space. We have therefore investigated the effect of altering cation size and processing temperature on the electron transport properties and local structure of the In-X-O system where X = Sc, Y, La. The former is achieved by variable temperature thin-film transistor measurements, and the latter by X-ray absorption spectroscopy and *ab initio* molecular dynamics simulation. This combination allows a more complete understanding of how local coordination and oxide polyhedra interconnectivity affect electron transport, and provides insight into designing new oxide semiconductors.

*Biography*: Jeremy Smith received his MSci degree in Materials Science from the University of Cambridge in 2007 and his PhD in the Physics Department at Imperial College London. His research, under the supervision of Prof. Thomas D. Anthopoulos, was focused on the development of high mobility organic field-effect transistors with a particular interest in the links between thin-film morphology and charge transport. He then worked in Prof. Tobin Marks's group at Northwestern University on solution processed amorphous oxide semiconductors for printable, thin-film electronics, and is now conducting research with Prof. Vivek Subramanian at UC Berkeley.