Progress Toward a Self-Aligned, Roll-to-Roll Manufacturing Process for Printed Circuitry

C. Daniel Frisbie
Department of Chemical Engineering & Materials Science, University of Minnesota, USA

"Printed electronics" has a number of significant challenges, including spatial resolution, pattern registration, and printed circuit performance. In this talk I will describe a patented liquid-based fabrication approach developed at Minnesota that we term SCALE, or Self-Aligned Capillarity-Assisted Lithography for Electronics. The SCALE process combines imprint lithography with inkjet printing and plating processes to produce self-aligned devices with feature sizes that are currently as small as 2 μm. Beyond the critical self-alignment aspect, SCALE offers a number of possible advantages for printed electronics manufacture including compatibility with roll-to-roll (R2R) manufacturing, excellent spatial resolution, conventional height-to-width aspect ratios for conductor lines, and sharp, well-defined line edges of all printed features. This talk will provide an update on the use of R2R SCALE to build arrays of discrete device components including resistors, capacitors, diodes, interconnects, and transistors. As SCALE relies on capillary flow of electronic inks in imprinted features, some important fundamentals of capillary flow, and practical innovations for controlling flow, will also be covered.

Biography of the Speaker:

C. Daniel Frisbie is Distinguished McKnight University Professor and Head of Chemical Engineering and Materials Science at the University of Minnesota. He obtained a PhD in physical chemistry at MIT in 1993 and was an NSF Postdoctoral Fellow at Harvard. His research focuses on materials for printed electronics, including organic semiconductors and their applications in devices such as transistors and electrochromic displays. Research themes include the synthesis of novel organic semiconductors, structure-property relationships, organic device physics, and the application of scanning probe techniques. Recent efforts also include new manufacturing approaches for flexible electronics and the use of gel electrolytes as high capacitance gate insulators in OTFTs to lower drive voltages. From 2002-2014, Frisbie led a multi-investigator effort in Organic Optoelectronics at the University of Minnesota, sponsored by the Materials Research Science and Engineering Center (MRSEC) program of the NSF. He was the lead investigator on a Multi-University Research Initiative (MURI) grant funded by the Office of Naval Research from 2011-2017 for development of a roll-to-roll printed electronics manufacturing platform.