Development of high performance polymer transistors and circuits with metal nanoparticle electrodes

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Printing is an emerging approach for low-cost, large-area manufacturing of electronic circuits, but it suffers from poor resolution, large overlap capacitances, and film thickness limitations resulting in slow circuit speed and high operating voltages. In the presentation, I will talk about how we can achieve perfect downscaling polymer transistors with sub-micrometer channel length. A self-aligned printing approach that allows downscaling of printed organic thin-film transistors to channel lengths of 100 – 400 nm with gold nanoparticle inks. The use of a cross-linkable polymer gate dielectric with 30-50 nm thickness ensures that basic scaling requirements are fulfilled and operating voltages are below 5 V. The device architecture minimizes contact resistance effects enabling clean scaling of transistor current with channel length. A self-aligned gate configuration minimizes the parasitic overlap capacitance to low values of down to 0.2-0.6 pF/mm and provides a significant improvement of transistor switching speed over 1.6 MHz. Our self-aligned process provides a path for improving the performance of printed organic transistor circuits by downscaling while remaining compatible with the requirements of large-area, flexible electronics manufacturing.