High resolution patterning of oxide semiconductor transistor by electrohydrodynamic jet printing

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Patterning techniques for the semiconductor materials have been another technological issue for downward scaling of feature sizes in ways that offer the potential for large-area, low-cost processing. Ink-jet printing has been considered as a promising patterning technique for this purpose, but its direct resolution is limited to the range of ~25 μm (generally hundreds μm line width).[1, 2] This presentation explores transport in transparent thin film transistors formed using a liquid precursor to indium zinc oxide, delivered to target substrates by the techniques of high resolution electrohydrodynamic jet (e-jet) printing. Under optimized conditions, we observe effective field effect mobilities as high as 32 $cm^2V^{-1}s^{-1}$, with on/off current ratios of 10^3, and threshold voltages of 2V. These results provide evidence that material manipulated in fine-jet, electric field induced liquid flows can yield semiconductor devices with good properties, even when employed with the active materials, without any adverse effects of residual charge or unintentional doping. A main advantage is the ability of e-jet printing methods to access levels of resolution (~1.5 μm) that are substantially better than those possible using conventional ink jet printing approaches, thereby providing a promising path to printed transistors with small critical dimensions.

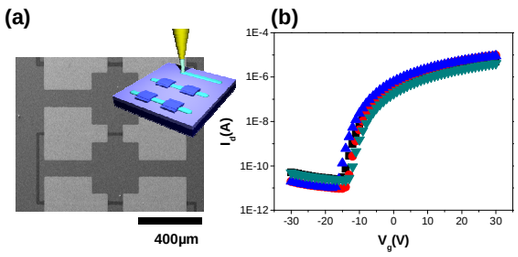

Figure 1. (a) Scanning electron microscope image of IZO transistors (b) Transfer characteristics of IZO transistor

[1] Kim D, Jeong Y, Song K, Park S K, Cao G Z and Moon J 2009 Inkjet-Printed Zinc Tin Oxide Thin-Film Transistor *Langmuir* **25** 11149-54

[2] Sirringhaus H, Kawase T, Friend R H, Shimoda T, Inbasekaran M, Wu W and Woo E P 2000 High-resolution inkjet printing of all-polymer transistor circuits *Science* **290** 2123-6