

## Fabrication of fully-printed short-channel organic thin-film transistors

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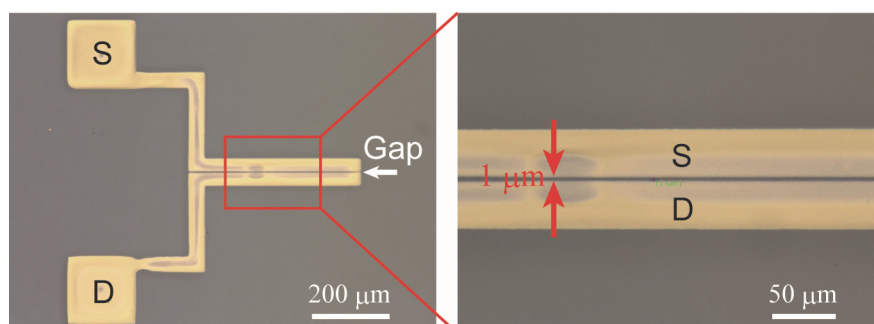
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Printed electronics is an emergent subject for the low-cost and large-area fabrication of flexible electronic devices. Direct printing of organic thin-film transistors (OTFTs) using soluble organic semiconductors is a particularly promising fabrication method that offers lower production costs, reduced energy consumption, and a smaller environmental burden [1]. We have also reported fully-printed OTFTs using room-temperature fabrication process without use of annealing [2]. One of significant problems remained is limitation in decreasing the size of devices because of the poor resolution of current printing technologies. Particularly, drive frequency of OTFT devices increases as the channel length decreases. Thus it is one of the most significant challenges to fabricate short-channel devices based on printing techniques.

We have developed the surface selective deposition method as the high-resolution printing technique, which permits the patterning of metal nanoparticle ink based on the surface wettability difference. The patterned wettabilities on surface were produced by vacuum ultraviolet (VUV) irradiation. After preparation of the hydrophobic polymer surface, the selected regions were exposed to VUV irradiation through a photo mask under ambient atmospheric conditions, resulting in surface patterning into hydrophobic and hydrophilic regions. Then, the metal nanoparticle ink was applied to the surface to obtain the patterned metal electrodes. We employed a parallel VUV light (wavelength of  $\sim 200$  nm) as the light source, allowing us to reduce the lines and spaces of printed structures down to  $1 \mu\text{m}$  (Fig. 1).



**Fig. 1. Source/drain electrodes of OTFTs fabricated by the surface selective deposition method. The gap length can be reduced down to  $1 \mu\text{m}$ .**

We have successfully fabricated fully-printed short-channel OTFTs using the surface selective deposition method. The short-channel devices showed high performance because of the low contact resistance at metal/organic semiconductor interface. These results suggest that this fabrication method is very promising as a core technology for low-cost and high-performance printed electronics.

### References

1. T. Minari, C. Liu, M. Kano, and K. Tsukagoshi, *Adv. Mater.*, 24, 299 (2012).
2. T. Minari, Y. Kanehara, C. Liu, K. Sakamoto, T. Yasuda, A. Yaguchi, S. Tsukada, K. Kashizaki, and M. Kanehara, *Adv. Funct. Mater.*, 24, 4869 (2014).