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All-printed Arrays of Thin Film Transistors Based on Liquid Metal Inks on Flexible Substrates

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Abstract

Printable electronics is an innovative technology with a superior advantage of quick manufacture in large areas, which will hold a great promise for soft wearable devices,[1] solar cells,[2] radio frequency identification tags (RFID)[3] and other amazing applications. To enrich the functionality of current soft electronic products, fundamental elements such as flexible transistors must be obtained, which will structure the logical units of those more advanced facilities. As conductive materials with miscibility and controllable fluidity, the room-temperature liquid metal alloys (LM) are admirable novel options for flexible electronics, and particular focuses have been dedicated to the optimization of LM inks, printing equipment and craft.[4, 5] Herein an array of all-printed liquid metal thin film transistors (LMTFTs) on the flexible substrate is developed. Considering the availability of printing technology and demand for the channel size, electrodes were designed in the toothed pattern ($0.2 \times 2\ mm^2$) for each tooth. The length and width of a channel between two teeth were 200 μm and 2 mm respectively, thus acquiring a total channel width of 10 mm. The single LMTFT featured a side-gate layout ($0.7 \times 3\ mm^2$), with a 200 μm distance from another two electrodes (Figure 1a). Using Ga-based liquid alloys with selected components to obtain proper stickiness, the specific LM printer could well reach the accuracy mentiond above. Additionally, the channel material was P3HT semiconducting polymers while a typical ion gel made of [EMIM][TFSI] and PVDF-HFP was employed as the dielectric layer. The all-printed side-gate LMTFT displays properties of p-type, where the hole mobility and on / off ratio are $5.9\, cm^2V^{-1}s^{-1}$ and 4.3×10^3 , respectively (Figure 1b, 1c). Furthermore, these functional units can show simsilar transfer & output characteristics, which confirms a good uniformity of the single element in an array. This research will lay a foundation for rapid manufacture of advanced logic circuits & systems on soft substrates based on liquid metal in the future.

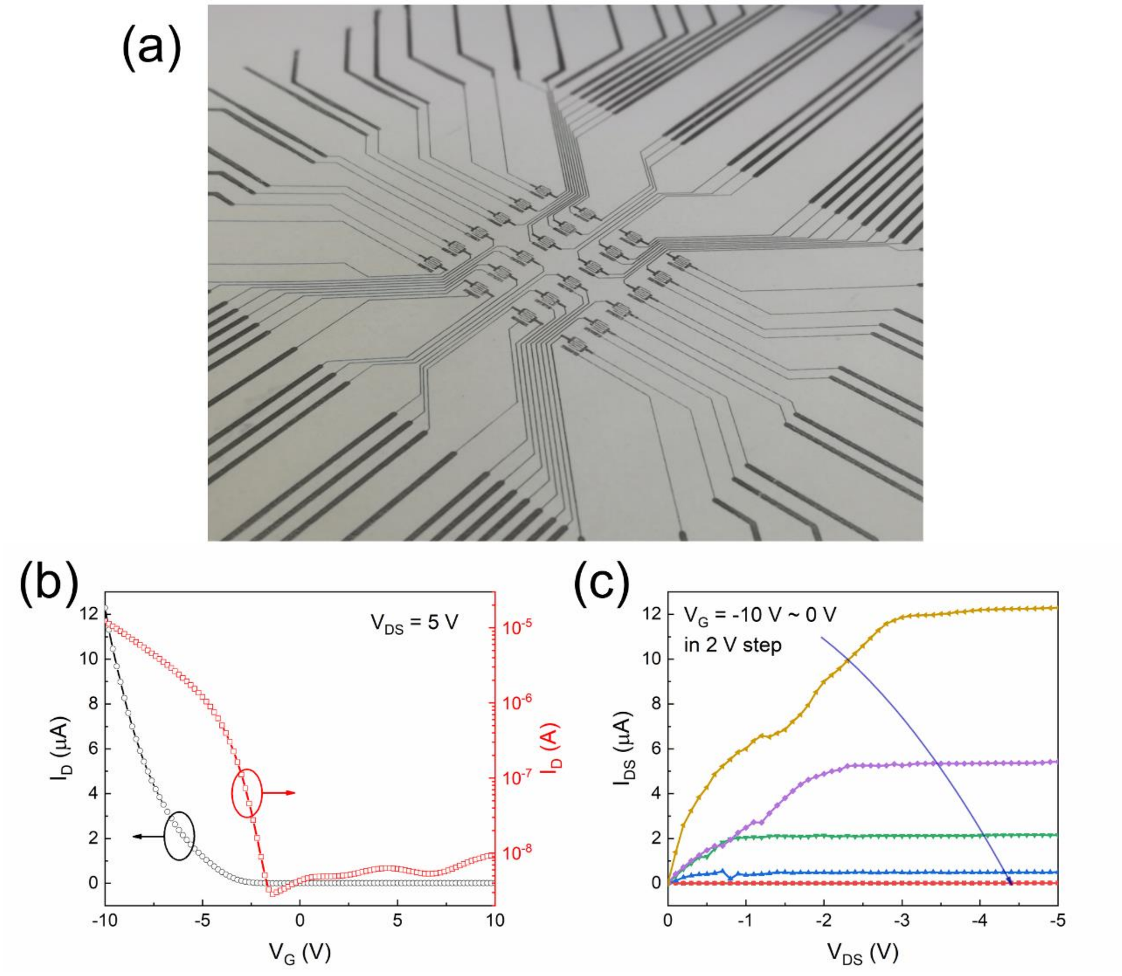

Figure 1: The image and performance of LMTFT. (a) The image of electrodes from the all-printed LMTFT array on a soft white paper. (b) Transfer characteristics of the LMTFT. (c) Output characteristics of the LMTFT.

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