Scalable ultrahigh-speed fabrication of uniform crystalline thin films for organic transistors

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Utilization of printing technologies to fabricate organic semiconductor thin films is expected for low-cost production of the devices for flexible electronics. However, large-scale high-speed fabrication of uniform organic semiconductor thin films with adequate electrical properties for these devices remains a big challenge.

In this study, we demonstrate an ultrafast and scalable fabrication of uniform crystalline thin films with 100% surface coverage using liquid crystalline semiconductors such as Ph-BTBT-10 and C8-BTBT, at a rate of 3 orders of magnitude higher than before by dip-coating.

The schematic illustration of a homemade dip-coater is shown in **Fig. 1**. The solution container was placed on a hot stage maintained at optimized temperatures of SmE phase of Ph-BTBT-10[1,2] or SmA phase of C8-BTBT. Crystalline thin films were fabricated on a BCB-modified SiO_2/Si-substrate by withdrawing a substrate from a Ph-BTBT-10/C8-BTBT p-xylene/toluene solution at a given constant rate from 1 mm/s up to 40 mm/s of the fastest limit of our dip-coater.

Fig. 2 shows the summary of FET performance of Ph-BTBT-10 films dip coated at various rates. When the withdrawal rate is faster than 1 mm/s, the average FET mobility of over 4.0 $cm^2V^{-1}s^{-1}$ was obtained, and it slightly decreased as the rate was increased.

The scalable fabrication of the crystalline thin films was examined with a different size of substrate from 1 inch square up to 4 inch square at 40 mm/s. **Fig. 3** shows optical images crystalline thin films fabricated on the different substrates. The average FET mobility for 234 FETs on 4 inch square was similar to that with a substrate size of 1 inch square one.

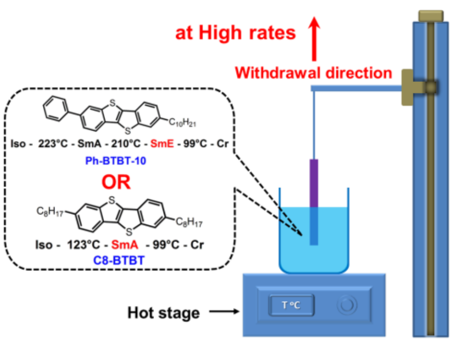

Fig. 1 Schematic illustration of experimental setup.

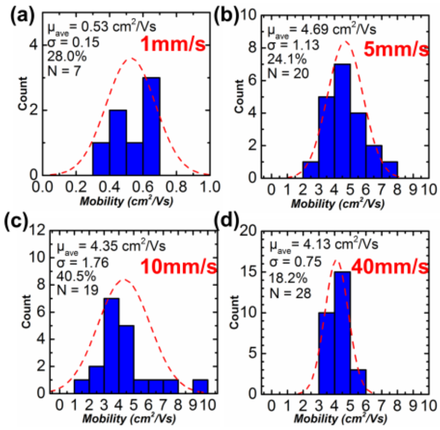

Fig. 2 FET performances of Ph-BTBT-10 thin films dip-coated at various withdrawal rates.

In summary, we found that uniform polycrystalline thin films with 100% coverage on the substrate can be fabricated with liquid crystalline semiconductors at an ultra-high withdrawal rate of 2.4m/min., and this technology are scalable without seriously sacrificing FET performance. The present results indicate that we come one step closer to realizing the printed electronics.

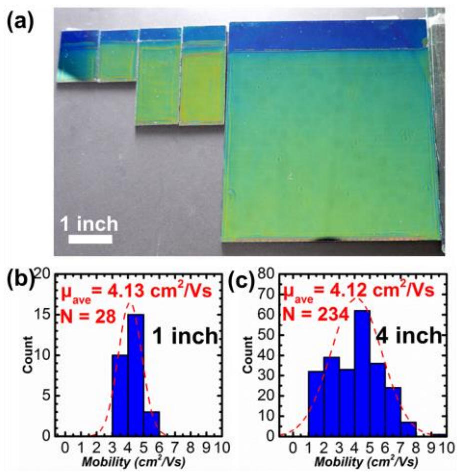

Fig. 3 Scalability for high-rate dip-coating of Ph-BTBT-10 thin films at 40mm/s.

References

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