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Hybrid complementary circuits based on organic/inorganic flexible thin film transistors with PVP/Al2O3 gate dielectrics

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Flexible inverters based on complementary thin-film transistor (CTFTs) are important because they have low power consumption and other advantages over single type TFT inverters. In addition, integrated CTFTs in flexible electronic circuits on low-cost, large area and mechanically flexible substrates have potentials in various applications such as radio-frequency identification tags (RFIDs), sensors, and backplanes for flexible displays.

In this work, we introduce flexible complementary inverters using pentacene and amorphous indium gallium zinc oxide (IGZO) for the p-channel and n-channel, respectively. The CTFTs were fabricated on polyimide (PI) substrate. Firstly, a thin poly-4-vinyl phenol (PVP) layer was spin coated on PI substrate to make a smooth surface with rms surface roughness of 0.3 nm, which was required to grow high quality IGZO layers. Then, Ni gate electrode was deposited on the PVP layer by e-beam evaporator. 400-nm-thick PVP and 20-nm-thick ALD Al2O3 dielectric was deposited in sequence as a double gate dielectric layer for high flexibility and low leakage current. Then, IGZO and pentacene semiconductor layers were deposited by rf sputter and thermal evaporator, respectively, using shadow masks. Finally, Al and Au source/drain electrodes of 70 nm were respectively deposited on each semiconductor layer using shadow masks by thermal evaporator.

Basic electrical characteristics of individual transistors and the whole CTFTs were measured by a semiconductor parameter analyzer (HP4145B, Agilent Technologies) at room temperature in the dark. Performance of those devices then was measured under static and dynamic mechanical deformation. Effects of cyclic bending were also examined. The voltage transfer characteristics (Vout- Vin) and voltage gain (-dVout/dVin) of flexible inverter circuit were analyzed and the effects of mechanical bending will be discussed in detail.

Keywords: complementary thin-film transistor (CTFTs), indium gallium zinc oxide (IGZO)