Fully Transparent Oxide Thin-Film Transistor with Record Current and On/Off Ratio

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Primary CNF Tools Used: PT720/740, PVD75 sputter deposition, Oxford ALD FlexAL, Autostep i-line stepper

Abstract:

Here we report making a fully depleted micrometer-scale barium tin oxide ($BaSnO_3$)-based fully transparent TFT that sources over 1.6 mA/μm of current with an on/off ratio over 10^8 and a peak mobility of 68 $cm^2V^{-1}s^{-1}$ at room temperature. Further scaling of these TFTs is expected to provide performance rivaling today's most advanced and scaled transistors. Our results demonstrate the tremendous potential of $BaSnO_3$ for the future of transparent oxide electronics.

Summary of Research:

A fully transparent oxide TFT based on $BaSnO_3$ has been fabricated with record drain current and on/off current ratio. This breakthrough is made possible by (1) high mobility bare films in combination with (2) the development of a micrometer-scale etching method for $BaSnO_3$ that preserves the surface roughness, conductivity, resistivity and mobility of $BaSnO_3$ films. These results demonstrate the tremendous potential of $BaSnO_3$ for the future of transparent electronics.

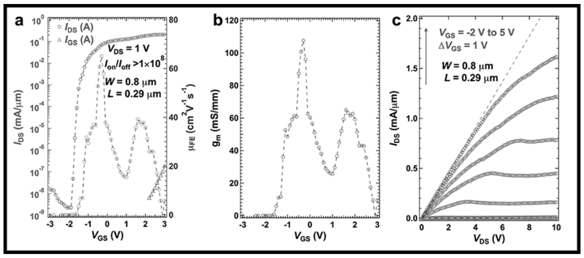

Figure 1: Thin-film transistor based on La-$BaSnO_3$. a, The transfer characteristic of the TFT in the linear region (V_{DS} = 1V) and the transconductance. The peak field-effect mobility is 68 $cm^2V^{-1}s^{-1}$ and the on-off ratio is over 10^8. The subthreshold swing is 0.1 V dec^{-1}. b, Transconductance of the device at V_{DS} = 1V. The maximum transconductance is 10^7 mS/mm. c, The output characteristic of the device at V_{GS} = -2, -1, 0, 1, 2, 3, 4, 5 V. The maximum drain current exceeds 1.6 mA/µm.

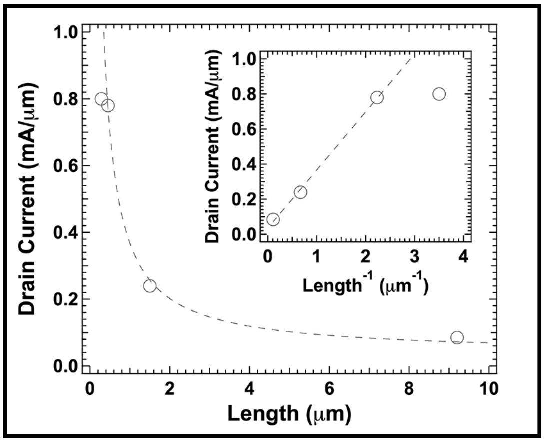

Figure 2: Drain current dependence on channel length (L) when V_{GS} = 3 V and V_{DS} = 10 V. The drain current (I_{DS}) is inversely proportional to the overall channel length except at the shortest channel length, showing little degradation with respect to device scaling. The deviation from linear behaviour in the inset at the shortest channel length is consistent with a velocity saturation effect: the degradation of the mobility and thus the drain current as the carrier velocity is limited by increased scattering rate at the high electric field at short channel length.

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