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### **Carbon nanotube and oxide nanobelt FETs: fabrication, characterization and applications<sup>1</sup>**

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High-performance field effect transistors (FETs) based on single-wall carbon nanotubes (SWNTs) and oxide nanobelts were fabricated and characterized. The SWNT-FETs were constructed via molecular template-directed assembly of HiPCO tubes onto pre-patterned metal electrodes on a Si/SiO<sub>2</sub> substrate. The devices exhibit operating characteristics comparable to state-of-the-art CNT FETs, and the process is amenable to large-scale functional CNT circuit assembly. Importantly, the integration of hydrophobic self-assembled organic monolayers in the device structure eliminates the primary source of gating hysteresis in SWNT-FETs, which leads to hysteresis-free FET operation while exposing unmodified nanotube surfaces to ambient air<sup>[1]</sup>. Individual oxide (SnO<sub>2</sub> and ZnO) nanobelt FETs with multi-terminal contacts were fabricated via conventional lithography. Simultaneous two-terminal and four-terminal measurements enabled direct correlation of the FET characteristics with the nature of the contacts. Low-resistance ohmic contacts on the nanobelts result in high-performance n-channel depletion mode FETs with well-defined linear and saturation regimes, and “on/off” ratio as high as 10<sup>7</sup> at ambient conditions<sup>[2]</sup>. Intrinsic values of the carrier concentration and effective mobility for the nanobelts were consequently obtained. Channel-limited SnO<sub>2</sub> nanobelt devices show significant modification of the FET characteristics when exposed to gas flows containing 0.2-2% H<sub>2</sub> at room temperature. The gas sensitivity and response were carefully evaluated<sup>[3]</sup>. The effort to utilize the channel-limited nanobelt FETs for protein detection will be discussed. <sup>[1]</sup>S.A. McGill et al., APL **89**, 163123 (2006). <sup>[2]</sup>Y. Cheng et al., APL **89**, 093114 (2006). <sup>[3]</sup>L.L. Fields et al., APL **88**, 263102 (2006).

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