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Carbon nanotube and oxide nanobelt FETs: fabrication, characterization and applications[1]

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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_2 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[1]. Individual oxide (SnO_2 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 10^7 at ambient conditions[2]. Intrinsic values of the carrier concentration and effective mobility for the nanobelts were consequently obtained. Channel-limited SnO_2 nanobelt devices show significant modification of the FET characteristics when exposed to gas flows containing 0.2-2% H_2 at room temperature. The gas sensitivity and response were carefully evaluated[3]. The effort to utilize the channel-limited nanobelt FETs for protein detection will be discussed. [1]S.A. McGill et al., APL **89**, 163123 (2006). [2]Y. Cheng et al., APL **89**, 093114 (2006). [3]L.L. Fields et al., APL **88**, 263102 (2006).

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