Local Transport Imaging in a SnO_2 Nanobelt Sensor in a "Real World" Environment

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Electronic transport in a SnO_2 quasi 1D nanostructure device in a field effect transistor configuration is studied with a combination of macroscopic transport measurements and Scanning Probe Microscopy (SPM). The geometric structure of the nanobelt is determined from atomic force microscopy images that provide the height of the nanowire and scanning electron microscopy images that yield the cross-section. To address local transport behavior in the nanobelt, ac and dc potential distributions in an operating sensor device were measured using scanning impedance microscopy and Scanning Surface Potential Microscopy (SSPM) correspondingly. SSPM images exhibit dc potential drops at the contacts and at the local defects, which are the primary electroactive elements in the nanowire circuit. The dc transport measurements are strongly affected by the field-induced surface charge on the nanowire and gate oxide, low mobilities of which results in relaxation times of order of hours at room temperature. Under the conditions when charging effects are minimal, the potential distribution along the nanowires under positive and negative biases is strongly asymmetric, indicative of the presence of rectifying elements in the circuit. SPM is used to measure the current-voltage characteristic of individual electroactive elements in nanowires circuit. Combined with macroscopic sensing characteristics, this provides an opportunity for a spatially-resolved understanding of sensing and memory mechanisms in these devices.

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