Electrostatically Formed Nanowires: a Novel Platform for Sensors, and Other Electronic Devices

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We present a new paradigm in nanowire based devices termed Electrostatically Formed Nanowires (EFN). The EFN is composed of a nanowire-like conducting channel that is not physically fabricated, but electrostatically formed post fabrication. The conductive channel is a doped silicon region surrounded by four gates: a back gate, two lateral junction gates, and a top dielectric that functions as a molecular gate. The size and shape of the EFN is defined and tuned by controlling the bias applied to the surrounding gates. We demonstrate the use of EFN for sensing of various gases including Ethanol, Acetone, and various n-alcohols and n-alkanes.[1] By electrically tuning the EFN diameter for a particular concentration range, the sensitivity as well as the overall dynamic range over which the sensor operates is highly enhanced; this tunable sensitivity is attributed to the nanowire size and shape controlled electrically.[2] It is also found, that in addition to polar target molecules, the EFN sensor is also capable of detecting non-polar alkanes, without any explicit additional surface treatment. The underlying mechanism responsible for the observed phenomena is attributed to interplay between the alcohol/alkane-silicon oxide interaction, induced surface EFN electric field and inherent molecular properties of our target species. We also demonstrate the application of the EFN to temperature sensing, multiple state transistors and other novel electronic devices.

[1] N. Swaminathan, Alex Henning, Yonathan Vaknin, Klimentiy Shimanovich, Andrey Godkin, Gil Shalev, and Yossi Rosenwaks„ *ACS Sensors* **688**, 2016 (1).
[2] 2. A. Henning, M. Molotskii, N. Swaminathan, Y. Vaknin, A. Godkin, G. Shalev, and Y. Rosenwaks, *Small* **11**, 4931 (2016).