UV-assisted alcohol sensors using GaN nanowires functionalized with ZnO and SnO_2

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I. Motivation

Fabrication of nanowire gas sensors with low power, reduced size increased surface to volume ratio with added capability to

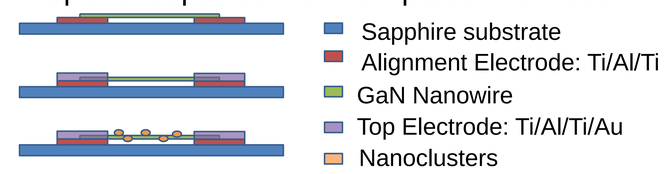
- Operate at room temperature
- Tune selectivity and sensitivity
- Make nano-sensor array

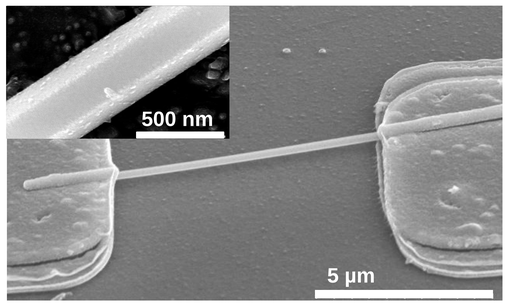
II. Highlights

- Chemically inert GaN nanowires (NW) functionalized with metal oxide nanoparticles
- UV light assisted sensing at room temperature
- ZnO and SnO_2 nanocluster coated GaN sensors are selective to alcohols.
- Sensitivity and selectivity tuned by light intensity

III. Device fabrication

- Photolithography for fabrication of electrodes
- Dielectrophoretic alignment of nanowires
- Rapid thermal anneal for ohmic contacts
- Sputter deposition for nanoparticle formation





SEM image of the NW bridge (inset- ZnO nanoclusters on the GaN NW)

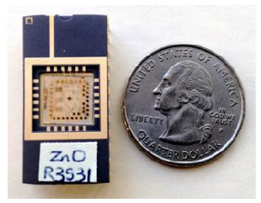
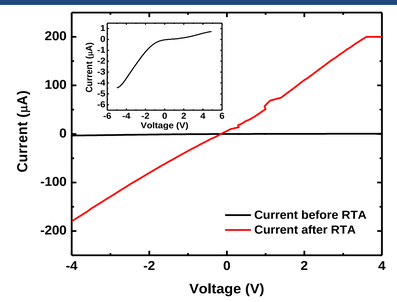
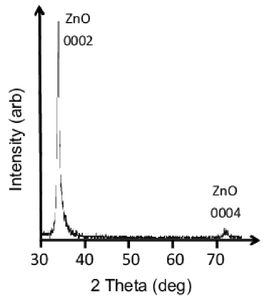


Image of a device wire bonded onto a chip carrier.

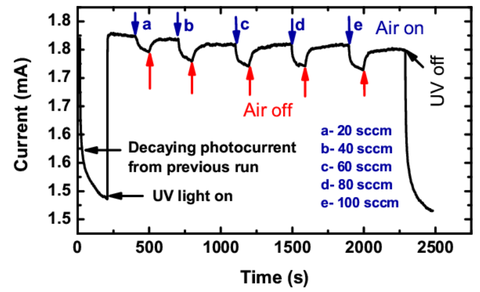


I-V characteristic of the device.

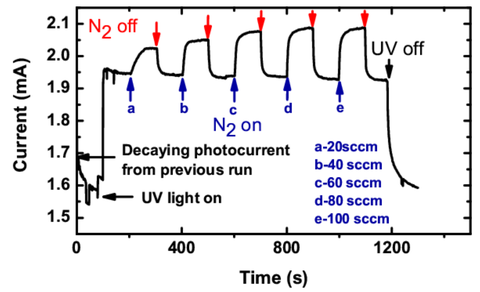


XRD Ω-2Θ scan of a 300 nm thick ZnO film.

IV . Response to air and N_2

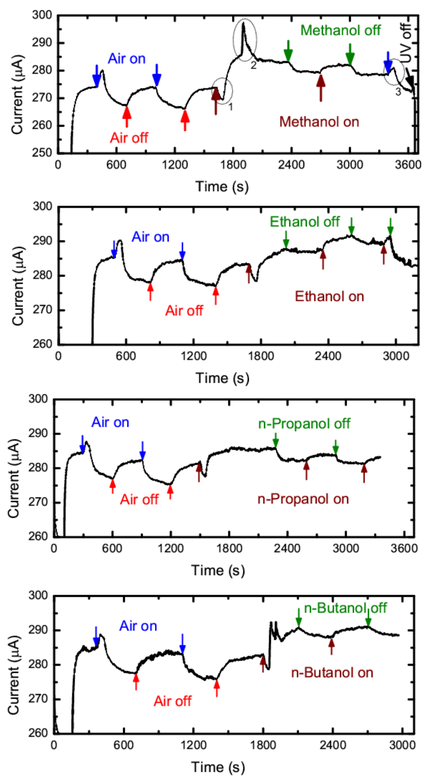


Response to air

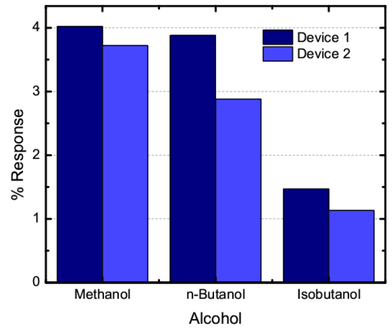


Response to nitrogen

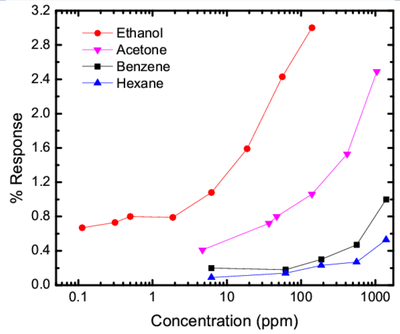
V . Response to alcohols



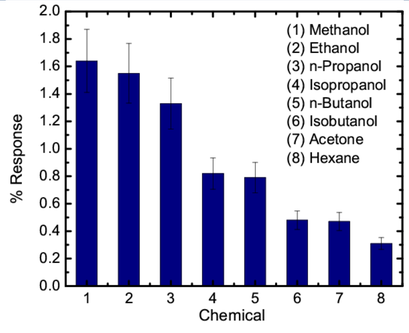
VI. Relative response



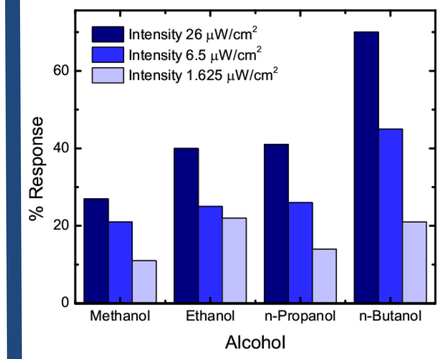
Response of two ZnO NP/ GaN NW devices to methanol and butanol



Response of ZnO NP/ GaN NW devices to different chemicals



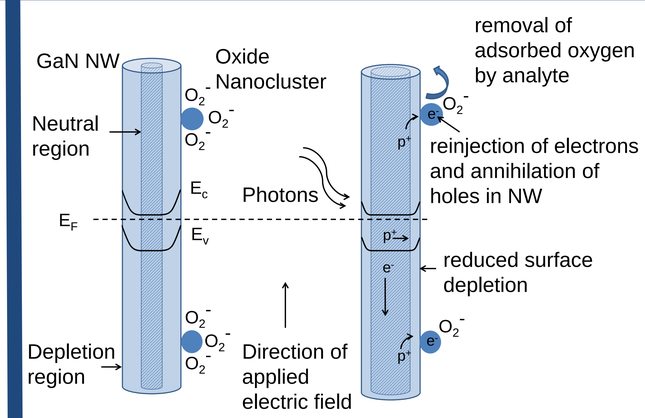
Response of two SnO_2 NP/ GaN NW devices to different gases



Response of ZnO NW device to alcohols under varying intensity

- Study the sensitivity and selectivity of photo- assisted sensing devices with varying light intensity (in collaboration with C.-C. Huang and J.F. Conley, Jr.at School of Electrical Engineering and Computer Science, Oregon State University).
- Interesting to note the response reversal for different alcohols between ZnO NP/GaN NW sensor and ZnO NW sensor.
- Possibly nanoparticles form a sieve on the GaN NW surface reducing the response for the bigger molecules.

VII. Sensing mechanism



$$2CH_3OH + O_2^-(ads.) \rightarrow 2HCOH + 2H_2O + e^-$$

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