Photovoltaic Application of Silicon Nanowire P-N Junctions

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The goal of this project is to design and develop a fabrication process for a silicon photovoltaic device which incorporates a vertical array of nanowire p-n junctions (Figure 1). The silicon nanowires are etched into a silicon wafer, comprising an epitaxial p-layer on n-substrate, via metal-assisted chemical etching (MACE) [1, 2]. The resulting nanowires contain p-n junctions that lie along the length of the vertical nanowires. This construct has the potential to increase the optical bandwidth of a silicon photovoltaic device by allowing a greater amount of short wavelength light to reach the junction. In addition, the MACE method of nanofabrication has the potential for decreasing the manufacturing complexity and related costs by eliminating the need for photolithographic patterning.

The fabrication procedure is presented, along with cross-sectional SEM images of the resulting nanowire arrays. Device fabrication considerations include inter-nanowire material, ohmic electrical contacts, and device passivation. Current vs voltage characteristics of the nanowire device are presented and compared to its planar analog. Of particular interest is the difference in short wavelength (UV) light response between nanowire and planar devices.

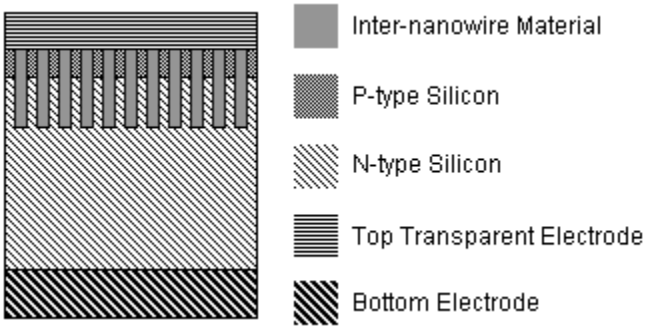

Figure 1. Schematic cross-section of silicon nanowire p-n junction device.

[1] Z. R. Smith, R. L. Smith, S. D. Collins, Mechanism of nanowire formation in metal assisted chemical etching, Electrochimica Acta 92, 139-147 (2013).
[2] R. Liu, F. Zhang, C. Con, B. Cui, B. Sun, Lithography-free fabrication of silicon nanowire and nanohole arrays by metal-assisted chemical etching, Nanoscale Research Letters, 8:155 (2013).

Preference: poster