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Si Wire-Array Solar Cells

SHANNON BOETTCHER, California Institute of Technology

Micron-scale Si wire arrays are three-dimensional photovoltaic absorbers that enable orthogonalization of light absorption and carrier collection and hence allow for the utilization of relatively impure Si in efficient solar cell designs. The wire arrays are grown by a vapor-liquid-solid-catalyzed process on a crystalline (111) Si wafer lithographically patterned with an array of metal catalyst particles. Following growth, such arrays can be embedded in polymethyldisiloxane (PDMS) and then peeled from the template growth substrate. The result is an unusual photovoltaic material: a flexible, bendable, wafer-thickness crystalline Si absorber. In this paper I will describe: 1. the growth of high-quality Si wires with controllable doping and the evaluation of their photovoltaic energy-conversion performance using a test electrolyte that forms a rectifying conformal semiconductor-liquid contact 2. the observation of enhanced absorption in wire arrays exceeding the conventional light trapping limits for planar Si cells of equivalent material thickness and 3. single-wire and large-area solid-state Si wire-array solar cell results obtained to date with directions for future cell designs based on optical and device physics. In collaboration with Michael Kelzenberg, Morgan Putnam, Joshua Spurgeon, Daniel Turner-Evans, Emily Warren, Nathan Lewis, and Harry Atwater, California Institute of Technology.