Semiconductor Nanowire Devices for Photovoltaic, Photodetection, and Photoelectrochemical Applications

Tech ID: 19379 / UC Case 2009-103-0

TECHNOLOGY DESCRIPTION

Semiconductor nanowires have been successfully utilized as building blocks for various electronic and photonic devices. In particular, vertically aligned semiconductor nanowire arrays offer the potential of high photoconversion efficiency compared to that of thin film devices given the nanowire properties of enhanced light absorption, improved carrier collection efficiency, and reduced optical reflectance.

UC San Diego researchers have developed photovoltaic devices and methods to fabricate said devices that utilize semiconductor nanowires with heterojunction photodiode structures to achieve significant device performance gains, e.g., broad band spectral response and high energy conversion efficiency. Heterojunctions can be formed by direct epitaxial growth of vertically aligned III-V semiconductor nanowire arrays on their substrate, particularly on Si wafer, which allows integration of functional III-V-nanowire structures with CMOS technology. The heterojunction bandstructure therein can be engineered by tuning the III-V alloy composition of the nanowires. For example, heterojunction photodiode devices formed by InAs nanowire arrays on Si substrate have been operated in photovoltaic mode and found to exhibit a visible-to-infrared photocurrent excitation profile. Heterojunctions can also adopt a coaxial or core-shell configuration, i.e., a doped nanowire core surrounded by a shell of complementary doping, with multiple quantum wells and superlattice structures being incorporated between the p-type and n-type regions in certain designs. This geometry enables high optical absorption along the long axis of the nanowires while considerably reducing carrier collection distance in the radial direction. The device fabrication methods include embedding the nanowire arrays in polymer matrices and application of transparent conductors as top electrical contacts. Moreover, the nanowire semiconductor devices can be implemented as high efficiency photoelectrochemical cells to break down water and CO2 for hydrogen generation and CO2 conversion to fuel, respectively.

INTELLECTUAL PROPERTY INFO

This invention has patents pending and is available for sponsored research and/or licensing.

OTHER INFORMATION

This NCD includes cases SD2009-103 *Direct Epitaxial Growth of III-V Semiconductor Nanowires on Si for Photovoltaic and Photodetection Applications* and SD2009-099 *High Efficiency Nanowire Photovoltaic Cells (Solar and Photoelectrochemical Cells)*. Please reference SD2009-103 for inquiry purposes.

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	8,932,940	01/13/2015	2009-103

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OTHER INFORMATION

KEYWORDS

III-V semiconductors, nanowires, Si, epitaxial growth, photovoltaic, photodetector, photoelectrochemical cell, solar cell

CATEGORIZED AS

- **Nanotechnology**
  - Tools and Devices
- **Semiconductors**
  - Design and Fabrication
  - Materials
- **Sensors & Instrumentation**
  - Other

RELATED CASES

2009-103-0