

Heterojunction Solar Cell Fabricated with Single-Crystalline GaN Nanorod Array

Arrays of one-dimensional nanostructures have important potential as building blocks for a variety of optoelectronic devices. They may be particularly useful in solar cells, because of their ability to carry photogenerated charges away from a junction region, thus minimizing recombination rates and improving conversion efficiencies. Now a team of researchers led by C.S. Lee and S.T. Lee at the City University of Hong Kong, H.T. Cong at the Chinese Academy of Sciences, and their collaborators have demonstrated a heterojunction solar cell based on an array of *p*-type GaN nanorods on an *n*-type Si substrate, with promising photovoltaic properties. They reported their findings in the December 10, 2008 issue of *Nano Letters* (DOI: 10.1021/nl801728d; p. 4191).

Gallium nitride is appealing for use in nanodevices because of its wide, direct bandgap, high-carrier mobility, good thermal and chemical stability, and its ability to be *p*- or *n*-doped. GaN nanorods are relatively easily grown on Si substrates with an oriented morphology and a large bandgap difference, making this an attractive potential combination for photovoltaic applications. Motivated by this logic, the Hong Kong group synthesized Mg-doped GaN nanorod arrays by thermally evaporating a powder mixture of GaCl₃ and MgCl₂ (molar ratio 30:1) for one hour at 850°C in a flow of high-purity ammonia and hydrogen onto a Si substrate that had been seeded with gold nanoparticles. The resulting nanorods had a uniform size distribution of approximately 100 nm in diameter and 1.0 μm in length, and were confirmed by high-resolution transmission electron microscope images to have a single-crystal wurtzite structure with no observable defects or amorphous shells. Energy-dispersive x-ray spectroscopy revealed that the Mg was uniformly distributed in each nanorod, in concentrations varying from 1.1 to 2.4 at. %.

The researchers next fabricated a solar cell using one of the arrays, by filling the spaces between the nanorods with insulating photoresist (PMMA) and then electron-beam evaporating a Ni/Au (30/50 nm thicknesses) electrode onto the nanorods and a Ti/Al (30/50 nm thicknesses) electrode onto the backside of the Si substrate. This *p*-GaN nanorod/*n*-Si heterojunction device, measuring 0.5 × 0.5 cm², was exposed to AM1.5G solar illumination with an intensity of 100 mW/cm², and was found to have a rectification ratio of better than 10⁴ at ± 0.5 V, a fill factor of 0.38, and a power conversion efficiency of 2.73%. Additionally, the nanorod array displayed a relatively low reflection coefficient, as was expected from its one-dimensional array form, thus functioning as an antireflection coating for the device.

The researchers said that these "aligned GaN nanorods can be directly incorporated into the device structure without a complicated fabrication process." These results suggest that one-dimensional nanostructure arrays of GaN are promising components in heterojunction solar cells, and may one day lead to a technology impact rivaling that of GaN in light-emitting diodes.

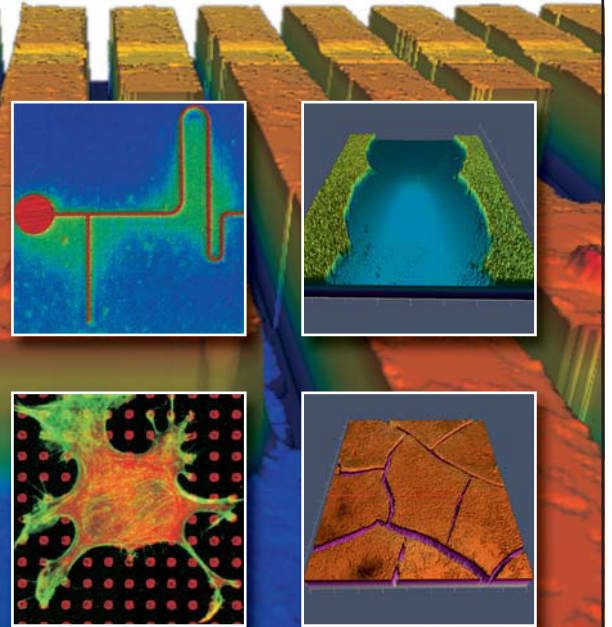
COLIN MCCORMICK

Urease-Functionalized Silica Enables Self-Mineralization

Hydroxylapatite (HAP) is found in teeth and bones, and is commonly used as a filler or surface coating in bone repair. Typically, coating deposition requires energetic, physically driven processes, such as plasma spraying and magnetron sputtering. Even solution-based processes require hydrothermal conditions that make unviable incorporation of labile bioactive compounds. Alternative, soft chemistry techniques require long time periods for HAP-like film formation. Biologically driven mineralization processes, however, have inspired biomimetic approaches for the preparation of biocomposites under mild conditions. Recently,

See More... Do More...

Integrated Solutions for Integrated Applications



LSM 700

Confocal Laser Scanning Microscope

Insight into Materials Science through:

- 3D Imaging
- Surface topography / Roughness
- Volumetric measurement
- Multi-label Imaging
- Fluorescence & Reflected light imaging

Applications in Research & Quality Assurance:

- Microfluidics
- Microarrays
- Microreplication
- Bio Materials
- Sensors
- Lab-on-Chip

Visit us at
Booth # 504

Carl Zeiss MicroImaging, Inc.

One Zeiss Drive
Thornwood, NY 10594
1-800-233-2343
micro@zeiss.com
www.zeiss.com/materials



Register to win a
pair of ZEISS binoculars
www.zeiss.com/binocs3



We make it visible.