Binh-Minh Nguyen, J Phys Chem Biophys 2014, 4:5
http://dx.doi.org/10.4172/2161-0398.S1.008

OMICS Group Conferences
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2nd International Conference and Exhibition on
Lasers, Optics & Photonics
September 08-10, 2014 Hilton Philadelphia Airport, USA

Unipolar core/multi-shell Ge/Si/Ge nanowires for ultra-high sensitivity infrared detector

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Ge photodetector is a popular commercial product for the near-infrared regime, which covers the important 1.3-1.55 μm optical fiber bandpass. We present here a novel Ge infrared detector architecture based on arrayed Ge nanowires that is compatible with Si substrate. The detector structure consists of an array of p-doped Ge/Si/Ge core/multi-shell NW with a thin Si layer as a potential barrier for holes. As the photon/charge converter, the radial junction configuration of the core/multi-shell NW enables charge collection in radial direction to minimize transport length and enhances operation speed, while high absorption is still guaranteed along the NW length. The main device junction is buried inside the NW, thus minimizing surface leakage which is detrimental in junction-exposed nanoscale devices. Moreover, the array geometry allows for increased light scattering, and efficient absorption even with small absorbing material volume, thus improved signal to noise ratio. The innovativeness of this device architecture is the presence of a barrier (B) in the valence band that blocks the transport of majority holes across the two p-doped regions, while photo-generated electrons in the conduction band are free to move. The absence of built in electric field and depletion region is the key difference with the conventional pin design. The NW geometry of the devices also makes plasmonic absorption enhancement with nano-particle decoration more efficient, and makes the system highly compatible with integration on Si-based electronics.

Biography

Binh-Minh Nguyen received a PhD in Electrical Engineering at Northwestern University in 2010. He is currently a Director's Postdoctoral Fellow at the Center for Integrated Nanotechnologies, Los Alamos National Lab. His research encompasses multi-disciplinary fields of materials science, applied physics and engineering, with a core expertise on physics of semiconductor materials and devices, hetero-epitaxy of nano-sytems, and advanced nano-fabrication/integration. He is author of six book-chapters and more than 60 papers with over 1200 citations. He was recipient of a SPIE Scholarship in 2009 and 2010; an IEEE Photonics Society 2010 Fellowship and the ECS's Edward Weston 2010 Summer Fellowship.

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