Nanotechnology to Improve the Efficiency of Space Solar Cells

Supporting/Contributing Agency: National Reconnaissance Office

Space Power research and development efforts with the Rochester Institute of Technology NanoPower Research Labs are dedicated to the development of new materials and devices for power generation and storage. This R&D focus is to exploit the potential opportunities afforded to us through nano-structured materials and nanotechnology.

The efficiency of space-based solar cells directly affects the mission lifetime, payload performance, and the ability to add additional capabilities and mission to space based assets. Nanotechnology inclusion in current triple-junction solar cells offers the opportunity to increase space based solar cell efficiency from 28% to 41%. This dramatic breakthrough comes from the use of Indium Arsenide (InAs) quantum dot layers, with appropriate strain compensation, to expand the spectral range and light conversion efficiency of the middle-junction of state-of-the-art Gallium Arsenide (GaAs) triple junction solar cells. Using nanotechnology to carry out bandgap engineering provides better matching to the solar spectrum and enables improved multi-junction current matching. Figure 1 shows a single layer of the deposited InAs quantum dots. Quantum Dot size varies from 10nm to 50nm. Up to 50 layers of QD can be added but strain compensation is essential to allow improved performance from the entire light spectrum.

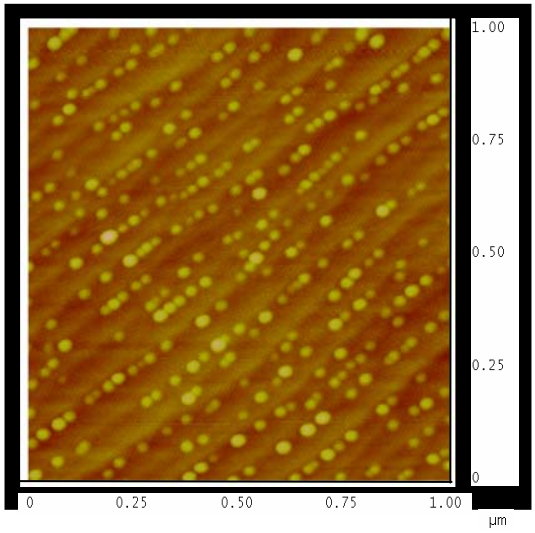

Figure 1. InAs Quantum Dots (10nm-50nm)

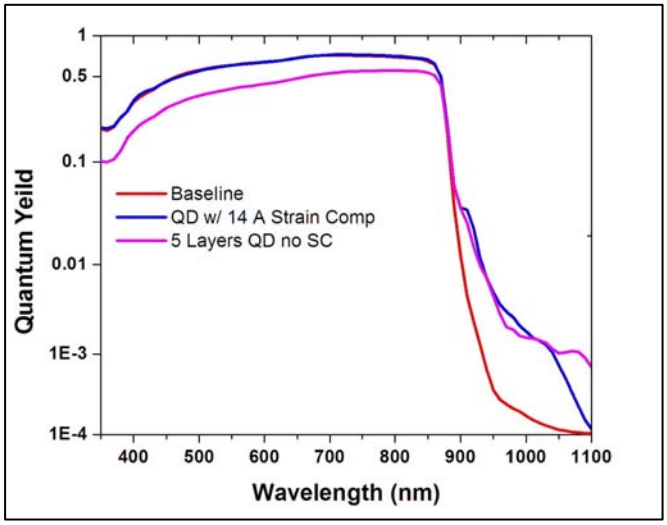

Figure 2. Spectral Enhancement with InAs QDs as demonstrated with increased photo-current above 900nm for both strain compensated and non-compensated QD layers.

Figure 2 shows the World's first demonstration of a net increase to overall solar cell photocurrent with the inclusion of InAs QDs to a GaAs solar cell. Note that above 900nm both the strain compensated (SC) and non-compensated QD enhanced cells outperform a standard state-of-the-art cell.

References/Publications

Raffaelle, R. and Landi, B., Nanostructured Space Photovoltaics – NanoPV, Program Review, Chantilly, VA, 12 November 2008.