Abstract Submitted
for the MAR11 Meeting of
The American Physical Society

Efficient Black Silicon Solar Cells with Multi-Scale Surface Texture FATIMA TOOR, WILLIAM NEMETH, MATTHEW PAGE, QI WANG, HOWARD BRANZ, HAO-CHIH YUAN, National Renewable Energy Laboratory — A nanostructured, density-graded surface layer can replace conventional quarter-wavelength coatings as the anti-reflection layer in photovoltaics. If the layer is comprised of structures smaller than the wavelength of the incident light and the density is graded across more than about half the wavelength of the light, reflection is strongly suppressed (H. M. Branz et al., APL **94** 2009). We developed an inexpensive liquid etch technique for silicon to produce "black Si" based upon this physics. However, the problem of high carrier recombination within this nanostructured layer must be overcome to improve beyond the present best solar cell with its confirmed 16.8% black silicon sunlight-to-electricity conversion efficiency (H-C. Yuan et al., APL **95** 2009). In this work, we combine the black Si layer with conventional KOH-etched pyramidal surface texture (Y. Xiu et al., Langmuir **24** 2008) at micron-scale. Pyramids contribute anti-reflection based on geometric optics. Combining the pyramids with nanostructures only 100 nm deep provides reflectivity below 2% across a wavelength range from 350 – 1000 nm. To-date, we have obtained a solar cell efficiency of 17% with a V_{oc} of 613 mV, J_{sc} of 35 mA/cm^2 and fill-factor of 78%. These cells have improved blue response compared to the best planar black Si cells.

Fatima Toor
National Renewable Energy Laboratory

Date submitted: 24 Nov 2010 Electronic form version 1.4