Triple-Junction Solar Cells for Solar Energy Harvesting, Foo

(aka: Indium Phosphide/Gallium Phosphide, Indium-Gallium-Arsenide and Indium-Gallium-Antimonide Based High Efficiency Multi-junction Photovoltaics for solar Energy Harvesting)

Sunlight is the most abundant source of renewable energy on the planet. Over 15,000 exajoules of solar radiation (aka solar irradiance) reach the earth's surface daily. The Earth's total recoverable energy from oil is only 3 trillion barrels or 17,000 exajoules of energy while the sunlight delivers that much energy to the earth in 1.5 days. The primary challenge in harnessing solar power is the cost. Solar electric power generation costs are significantly more than grid electricity - ~$1 per kwh versus ~10 - 15¢ per kwh. The high cost is driven by the efficiency of the solar cells in the market today where efficiencies of most solar cells range from 8 – 12%. Experts believe that cell efficiency needs to increase before solar energy can become more feasible and cost effective.

The new triple-junction solar cell developed by Florida State University (FSU) reaches simulated levels of efficiency significantly above current triple-junction solar cells, drawing closer and closer to the 60% theoretical efficiency limit of multi-junction solar cells. Multi-junction solar cells are the most efficient form of solar cell technology. Single junction solar cells, for example, can only absorb a certain wavelength of the solar spectrum, hence they are less efficient. In contrast, multi-junction solar cells absorb a significantly wider band of the solar spectrum. This is achieved by splitting the solar spectrum into smaller slices with multiple layers of semiconductor materials.

FSU's specific design uses a very special semiconductor layer which significantly improves the absorption of sunlight in wavelengths exceeding 598 nm, a range previously out of reach. Thus, the FSU triple-junction solar cell effectively absorbs all wavelengths of the solar spectrum by splitting the solar spectrum using the most optically sensitive materials for different wavelengths of the spectrum. Further research and tests are still being conducted and a prototype is in development. Simulations show the promise of our triple-junction solar cell reaching efficiencies of 50% or more. As efficiency increases, costs decrease ultimately making solar energy costs competitive with traditional sources of electricity.