Scientists Discover A New Approach To Developing Ultra High-Efficient Solar Cells

STATE COLLEGE, Pa.--(BUSINESS WIRE)--Scientists from the United States, Belgium and Korea are developing a new and novel approach for collecting and converting solar energy to DC output, which makes possible the design and fabrication of a new class of solar energy converters. This breakthrough science offers the potential for a dramatic increase in energy conversion efficiency and cost savings compared to current solar cells. The technology can successfully compete with and exceed in efficiencies and decreased costs when compared with today’s semiconductor-based solar cells. It is scalable, sustainable, adaptable and environmentally friendly and will allow manufacturers to quickly and economically shift to new materials if a shortage of any one type occurs.

The technology is based on a unique “optical rectification” process that uses a very simple, cost-effective, single element system that extracts energy from the solar spectrum from the infrared through the visible. This broad absorption of the solar spectrum very significantly contributes to the gain in efficiency when compared to current solar cells. The single element solar cell acts simultaneously as both a receiving antenna and as a rectifier to absorb and convert solar energy to an electric current. Such a device is historically termed a “rectenna” and was developed for microwave power transmission, achieving efficiencies up to 90 percent.

Since the device is fabricated using metallic antennas, there are no semiconductor band gap constraints or limitations. Furthermore the single element solar cell can operate at elevated temperatures. By contrast, temperature degradation affecting operation can occur in semiconductor based solar cells at about 200&#176F and higher.

In extensive computer simulations, scientists performed quantum-mechanical calculations of geometrically asymmetric metal-vacuum-metal tunnel junctions which model the single element rectenna device. In these simulations the junction is irradiated by light to simulate the solar spectrum. The results of computer simulations agree with the rectification results of the actual operation of the device. They also show rectification of light throughout the visible region and a significant DC current output. The scientists obtained efficiencies comparable to and exceeding those of current solar cell devices. Efficiencies as high as 50 percent were recorded.

The scientists are currently developing prototype devices which include more robust antenna structures and plasmonic effects to enhance output and efficiency.