Polymer scientist is laying groundwork for next-generation flexible photovoltaics

July 12 2011

University of Massachusetts Amherst polymer scientist Ryan Hayward recently received a five-year, $750,000 grant from the U.S. Department of Energy to improve understanding of the fundamentals for the next generation of lightweight and flexible electricity-conducting polymers. They are in limited use now in thin solar panels on messenger bags that can recharge a cell phone battery, for example.

Hayward and colleagues will study the physics of how polymer molecules crystallize and how they can be used to build solar-power-collecting nanostructures with the optimal combination of p-type/n-type (P-N) junctions for efficient light harvesting. This is expected to lead to a new crop of more cost-effective photovoltaic materials that are more efficient at conducting electrons than current technology.

When sunlight hits a photovoltaic device, electrons become excited and move to P-N junctions, then out of the device as electric power. One problem at present is that the motion of charges through polymer-based solar cells often is slowed to a crawl, a flow rate more like the stop-and-go of local traffic than a smooth expressway. One goal of Hayward and colleagues’ new research will be figuring out how to allow electrons to flow faster, enhancing the efficiency and cost effectiveness of charge transport in photovoltaics.

"As electronic materials, polymers have promise in terms of low cost and ease of processing," he says. "These materials are light and flexible, so they can be dissolved into a solution and sprayed onto a surface. There are now small solar panels available that are so flexible you can role them up like a map." But such applications are still rather expensive and not as efficient as they could be at producing electric power.

The UMass Amherst research group will conduct basic experiments to understand mechanisms involved in controlling structure and improving conjugated polymer performance. They will study self assembly of these materials across multiple length scales and develop new methods for preparing P-N junctions capable of efficient charge transport.

"For polymer-based electronics it's important to understand the structure of P-N junctions both on the length-scale of 10 nanometers, which is important for harvesting light, and on the scale of Angstroms, which is important for charge transport. We'll be trying to assemble new materials where we can control both the crystalline or molecular scale ordering and the nanoscale organization," Hayward points out.

As experts in polymer self-assembly, Hayward and colleagues will work with fellow UMass Amherst polymer scientist Todd Emrick and his research group, who synthesize a number of semi-conducting polymer materials.

"These are really interesting problems in fundamental science," Hayward notes. "We anticipate that the lessons we learn will be useful for many other areas in addition to photovoltaics, such as for polymer-based LEDs and transistors and other types of polymer-based electronics."

Provided by University of Massachusetts Amherst