Recent Progress in Plastic Solar Cell Technology

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Abstract

Along with the world economy growth is the growth of world energy consumption, especially that in the new developing countries – China, India, Brazil and Russia. Clean, abundant and sustainable renewable energy sources are the most important challenge of human being not only to satisfy world energy need, but also to protect the environment of our earth. The sun is the ultimate energy source with one hour of the solar irradiation energy on the earth almost equal to the world annual energy consumption. Photovoltaic (PV) technology has been dominated by crystalline silicon (~90% of market). However the high cost makes the wide application of difficult. Organic solar cell, especially polymer solar cell, holds promise of significantly reducing solar electricity cost, due to the very low material cost in the cell, low cost fabrication process (roll-to-roll for example), high material utilization etc. In addition, OPV also provides attractive properties like flexibility, wide range of colors (from organic chemistry), transparency etc., which could open new market opportunities.

Polymer solar cells are solution processable and compatible with large area low cost printing process, therefore easier to realize the cost competitive advantages of OPV. Efficiency-wisely, bulk heterojunction (BHJ) polymer solar cell also lead the way, with the National renewable Energy Laboratory (NREL) certified efficiency increasing quickly from below 6% in 2008 to almost 8% in just one year of time. This provides strongly evidence of the commercial viability of this technology. From the industry/ manufacture side, Konarka has done impressive job of producing polymer solar panel in a roll to toll process, and starts selling products. Krebs et al. in Denmark also demonstrated polymer solar cell panel using roll-to-roll manufacturing process with various large area coating/printing technologies.

In this presentation, we will discuss progress in three key areas of this promising technology to enhance polymer solar cell performance – (1) morphology control through thermal and solvent annealing; (b) device engineering through novel interface layers, inverted solar cell structure, tandem structure etc.; and (3) rational low band gap polymer development through bandgap and energy level tuning with the consideration of carrier mobility in the active material.

The solution processability of polymer solar cell could provide broad opportunity for traditional coating and printing industry. I will also present some recent results on polymer solar cell scale up through coating/printing process. Roll-to-roll fabrication of polymer solar cell, the success and challenges will also be discussed.

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