Designing materials and tandem architectures for polymer solar sells

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The power conversion efficiency of polymer solar cells depends on the quantum and energy efficiency by which photons from the sun are converted into electrical power. Absorption of light, charge generation, transport and collection all have to occur with high quantum efficiency and with minimal losses in energy.

Design strategies for the synthesis of improved conjugated polymers in combination with fullerene acceptors for efficient solar cells will be discussed. New materials feature extended optical absorption in combination with high, balanced charge carrier mobilities for holes and electrons and can be processed into efficient solar cells, depending on creating the optimal nanoscale morphology by controlling molecular weight and thin film processing conditions. In some examples, recombination of charge carriers into a triplet state on the polymer limits achieving higher efficiencies.

Multi-junction solar cells form a promising strategy to further increase the power conversion efficiency of polymer photovoltaics beyond the limits of single junctions. By combining the characteristics of representative single junction cells the optimal device layout can be accurately predicted. Examples of making and characterizing efficient tandem solar cells will be shown.