Photovoltaic materials based on Small molecules: an emerging approach to organic solar cells

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The development of clean and renewable energy sources is one of the major scientific and technological challenges for the next decades. In this context, the photovoltaic conversion of solar energy appears as one of the most attractive alternative to address global environmental issues.

In recent years thin-film organic solar cells have attracting increasing fundamental and technological interest motivated by the possibility to develop light-weight, large-area and cost-effective photovoltaic energy sources by simple and low-environmental impact technologies.

Donor-acceptor heterojunctions solar cells combining soluble fullerene derivatives as acceptors and donor materials based on conjugated systems are among the most efficient devices reported so far. The intense multidisciplinary research effort developed in the past decade has generated considerable progress and conversion efficiencies exceeding 8.0% have been reported for solar cells based on soluble conjugated polymers as donor material. However, the synthesis of conjugated polymers pose various problems related to the control of their structural regularity, molecular weight, polydispersity, end-group defects and batch to batch variations.

In 2005 our group has proposed an alternative approach based on the replacement of polydisperse polymers by soluble monodisperse molecular architectures as donor materials in BHJ. In fact, molecular donors present several specific advantages in terms of unequivocal chemical structure and perfectly reproducible synthesis and purification.

After a general presentation of the state-of-the-art on the various aspects of organic solar cells including active materials, device architecture and evaluation, various series of active materials based on small molecules will be discussed with an emphasis on the relationships between the molecular structure and properties of the active material and the performances of the resulting solar cells.