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# Novel Polymeric Materials for Organic Electronics and Solar Energy

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Plastic electronics has made great commercial and scientific progress over the past decade, predominantly driven by the potential of applications such as organic field effect transistors (OFETs) for flexible backplanes and e-paper, organic light emitting diodes (OLEDs) for large area lighting and displays and organic solar cells (OPV) for large area energy generation. Much of this work has been motivated by the fact that organic semiconductors can combine the superb mechanical and processing characteristics of plastics with a variety of printing techniques, enabling large-area, low-cost manufacturing. There has been an intensive worldwide research effort on the development of stable, conjugated organic semiconducting polymers as potential replacements for conventional silicon, the benchmark large area amorphous semiconductor. ID TechEx, the UK-based market research company, "estimates that over the last two decades global investments into plastic electronics technologies exceed US $10 billion, and predict that this will grow to almost US $25 billion by 2020".

The ecological and commercial motivation to implement the use of plastic electronics is compelling. Recently, such efforts have facilitated the development of thin film transistors for backplane applications such as e-paper. The ability to operate in ambient atmosphere without costly and rigorous encapsulation barriers to avoid water and/or oxygen is an important step towards commercialization. Research for cleaner alternatives of energy generation and advanced energy permitting devices has journeyed down an interesting path. The exploration of conjugated organic materials within the context of energy has led to the development of devices with great potential for utilization and exploitation within the near future, where perhaps the emergence of hybrid materials or the utilization of nano-architectonics will be of paramount importance to aid in the development of state of the art nanotechnology and its utilization within energy related themes. Meanwhile, further reducing of the cost is expected in the next decade as a result of designing next generation of energy devices (e.g. supercapacitors, solar cells, Li-ion batteries, fuel cells).

Organic PV active layers (especially polymer based materials) have the latent potential of solution based processing of the active layers, offering the attraction of low-cost, continuous roll-to-roll or printing processing of large area devices upon flexible substrates. These deposition techniques of the active layers may allow devices to meet the $15/m$^2$ target; for comparison paint costs about $1/m$^2$. **Furthermore, organic active layers offer infinite design space by virtue of the polymer architectures, providing potential for layers design and tunability to suit specific energy supply criteria.**

The development of more efficient energy-producing devices and cleaner energy generation alternatives continue to advance. The investigation of polymeric materials within the context of solar energy has thus far yielded devices with great potential. Through systematic chemical modification, the performance of OPV cells has advanced impressively over the last three years, with power conversion efficiency (PCE) now routinely surpassing 8%, and attracting industrial interest in commercializing this technology.

The synthesis of well-defined conjugated molecules/polymers is a considerable synthetic challenge that many excellent research groups have addressed over the last decade or so. A particularly promising class of potential donor/acceptor materials for use in BHJ solar cells and organic electronics are the aromatic donor-acceptor amido pigments diketopyrrolopyrrole (DPP) and isoindigo and the electron deficient bis-Thiazole (Figure 1)

Here, an electron-rich aromatic segment is positioned adjacent to a highly electron-deficient amide link typically known as a push-pull chromophore. When incorporated into small molecules or polymers, this structure affords very narrow band-gaps capable of harvesting a large percentage of the solar flux. Both DPP and isoindigo units have recently been used to construct some of the most efficient organic solar cells to date, and the present work capitalizes on these advances, and goes beyond.

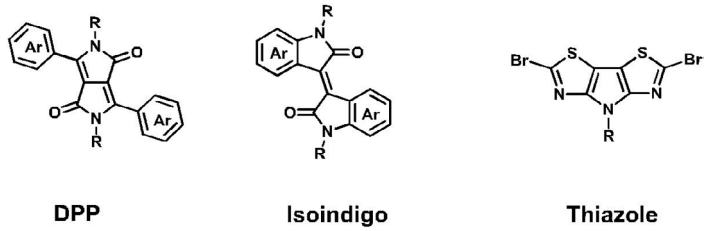


**Figure 1-** Chemical structures of DPP, Isoindigo and bis-thiazole.

Here we will present our synthetic efforts on developing the novel polymeric materials containing the three structures shown in figure 1, particular emphasis on a suit of carefully selected sidechains, which has provide access to a wide range of monomers with tuneable solubility (with either short or long, branched or linear alkyl chains). Moreover, the initial synthetic targets will specifically be the introduction of branched ocytyl-decyl chains as well as linear hexadecyl alkyl chains since they have both been used in other high efficiency conjugated polymers-the latter are known to enhance interchain interdigitation and close π-π stacking.