

New N-Type Polymers for Organic Photovoltaics and Other Electronic Devices

Dr. Silvia Luebben (P.I.) and Dr. Shawn Sapp

TDA Research, Inc. 12345 W. 52nd Ave. Wheat Ridge, Colorado 80033



Quad Chart:

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|---|---|
| <ul style="list-style-type: none"> Impact (Market/Societal) Huge Push For Flexible Electronics Potential for sea change in power generation, displays, logic, and lighting Global market for flexible electronics is estimated at \$10-30B by 2010 | <ul style="list-style-type: none"> Novelty (Technical) TDA's N-type polymers have lower HOMO level (more n-type) than other known materials Versatile structure allows a large variety of highly tuned products Have improved yield and polymer length by > 3x |
| <ul style="list-style-type: none"> Lineage (Origins-Technology) New N-type polymer structure envisioned, tested, and proven at TDA Research with help from CSU / NREL Initial polymers developed through two NSF SBIR Phase I awards Two patent applications submitted Launched two Boromer™ products in August, 2007 sold by Sigma-Aldrich | <ul style="list-style-type: none"> Company Mission (Team) Perform SBIR R&D, secure IP, scale-up, licensing, commercial production and sales. TDA – Technical team, licensing and negotiation, business development CSU – Semiconductor Testing NREL & Konarka – Modeling and OPV Testing Sigma-Aldrich – Initial sales, market development, and production scale-up. |

Introduction:

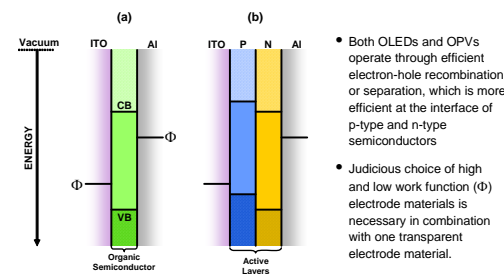
In the emerging field of organic printable electronics, such as organic light-emitting diodes (OLEDs) and organic photovoltaics (OPVs), there is a significant need for improved organic conducting and semiconducting materials. This poster presents our recent progress in the synthesis of new electron-deficient (n-type) semiconducting polymers.

New N-Type Organic Semiconductors

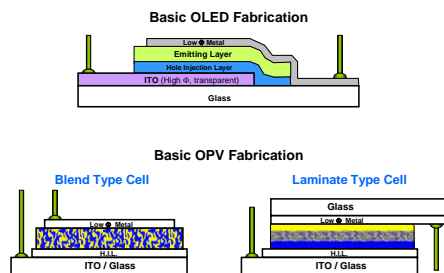
Organic Semiconductors and Electronics

- Pi-conjugated, organic molecules and polymers are semiconductors in an "un-doped" state
- Electron-rich structures tend to be p-type (donors)
- Electron-poor structures tend to be n-type (acceptors)
- P-type and n-type character arises due to relative differences in the valence band (HOMO) and conduction band (LUMO) energy levels
- There are many p-type semiconductors available
- Very few stable n-type semiconductors are known or available

Organic Semiconductors – Band Structure



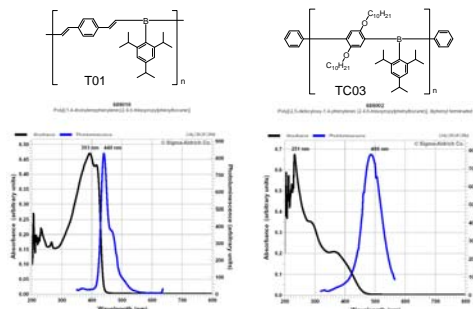
Organic Semiconductors – Application in Plastic Electronics



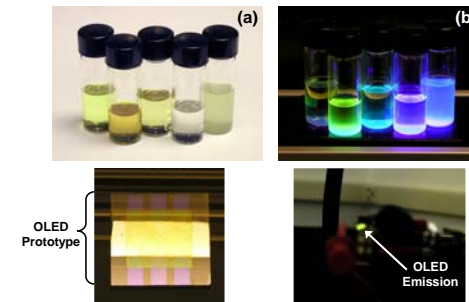
TDA's Approach – Aryl & Vinyl Boranes – Versatile Pi-Conjugated, Electron-Poor Structures

- Boron possesses a vacant p-orbital
- Boron can also form boron-carbon bonds
- Aryl boranes have been shown to be flat and further evidence shows the vacant p-orbital of the boron participates in the conjugation
- This leads to a very electron deficient (n-type) structure
- Boron-carbon bonds are labile unless sterically protected
- Pi-conjugated, sterically hindered, boron-containing polymer structures are possible (see Chujo et al.)

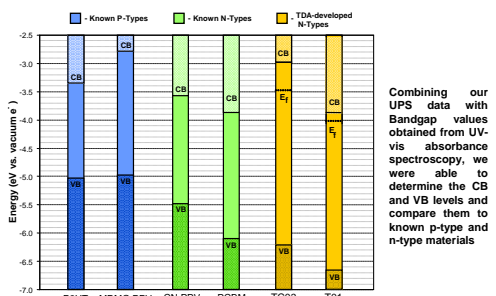
TDA's N-Type Materials – Structure & Properties



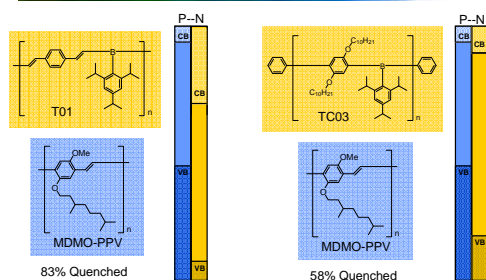
TDA's N-Type Materials – Emissive Properties



TDA's N-Type Materials – Energy Level Comparison



TDA's N-Type Materials – PL Quenching of MDMO-PPV



TDA's N-Type Material – Advantages

- Aryl-boranes and vinyl-boranes are structurally versatile
- TDA's materials have produced n-type semiconductors with deeper valence bands than known n-type materials
- These materials can be handled in air for short periods of time
- They are soluble in many organic solvents
- They have displayed a wide variety of UV-visible absorbance and fluorescence properties
- A number of materials have efficiently quenched the photo-excited state of MDMO-PPV, a well known p-type used in OPVs

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