A donor-acceptor molecule for thin film transistor applications containing quinoxaline and oligothiophene units

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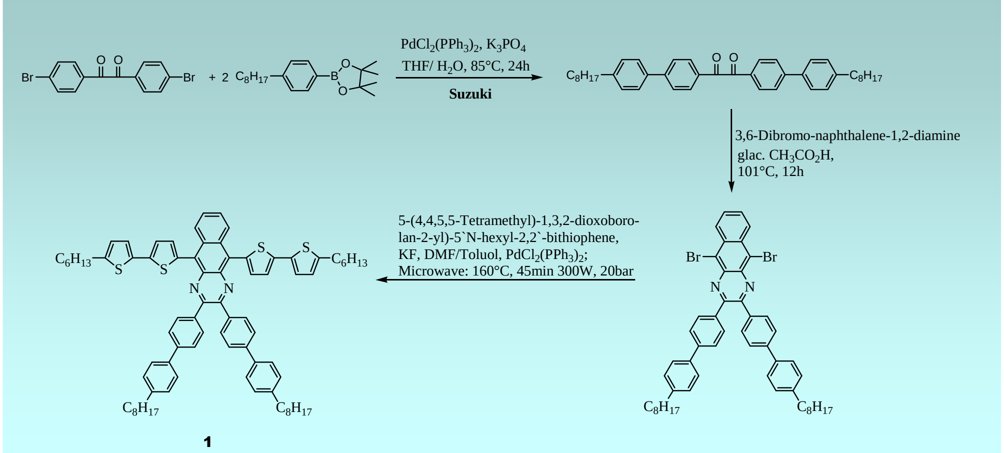
Introduction:

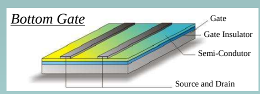
Small conjugated molecules with semiconducting properties are promising materials as components in electronic devices. Organic field effect transistors (OFETs) have the important advantages compared to amorphous silicon in that they can be deposited at lower temperature under reduced pressure or solution processing [1]. The possibility to use liquid-phase techniques such as ink-jet printing or spin coating is one of the most attractive features of organic thin film transistors. These organic semiconductors could therefore be used on flexible substrates as low cost electronics with high application volume.

In the growing field of OFETs materials, which support both n-type and p-type charge transport are interesting, so-called ambipolar organic semiconductors[2]. Given that quinoxaline rings have demonstrated n-type[3] semiconductor characteristics because of their high electron affinity and oligothiophenes are commonly used as p-type[4] semiconductors, we decide to synthesize a small molecule containing both these moieties.

Synthesis:



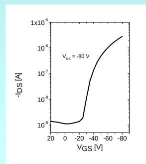
Application: OFETs



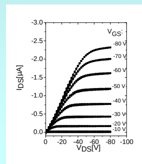
p-type OFET characteristics:

OFET Parameters	
μ [cm²/Vs]	$4.4 \cdot 10^{-4}$
On/Off Ratio	$2.2 \cdot 10^{3}$
V_t [V]	-20

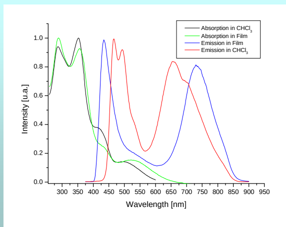
Output



Transfer



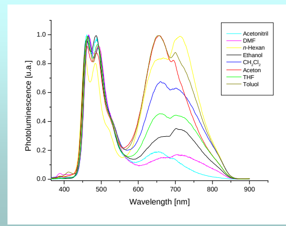
UV-Vis and Photoluminescence:



Optical properties:

	Polymer	5,10-(Hexyl-[2,2`]bithiophenyl)-2,3-bis-(octyl-biphenyl-4-yl)-benzo[*g*]quinoxaline [1]
Solution ($CHCl_3$)	Absorption (nm)	287, 352, 418 and 505
	Emission (nm)	467, 493, 657 and 700
Film	Absorption (nm)	288, 355, 430 and 522
	Emission (nm)	434 and 731

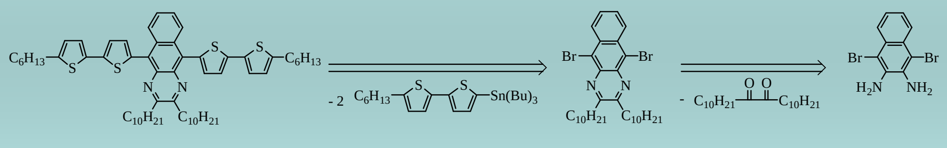
Solvent effect:



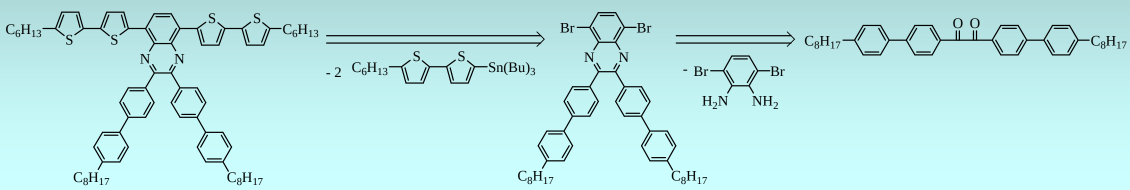
Results and Discussions:

- **1** was synthesized via a three step strategy. DSC measurements reveals one transition at 156°C attributed to melting.
- **1** shows reasonable transistor behaviour in the p-type mode. The n-type behaviour is under investigation.
- **1** shows a red-shifted long wavelength absorption band at 505nm (solution) probably due the formation of a charge transfer (CT) state. The solid state absorption spectrum shows a small bathochromic shift (17 nm) of this CT band.
- The photoluminescence spectrum (PL) displays two components in the visible region in solution and thin film. The low energy peak should represent the emission from the CT state.
- Interestingly the relative intensities of these peaks are solvent dependant.
- In thin film the CT-related emission is also red-shifted while the high energy band is blue-shifted.

Outlook:



- Replacing the bulky aryl groups by alkyl groups should result in better packing due to stronger π-π interaction and increased charge carrier mobilities.



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