Low bandgap materials for Organic Photovoltaics

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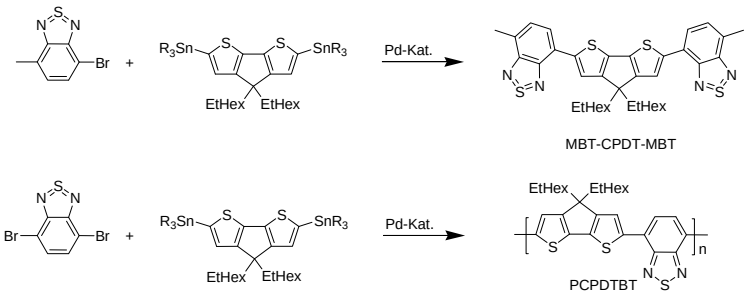
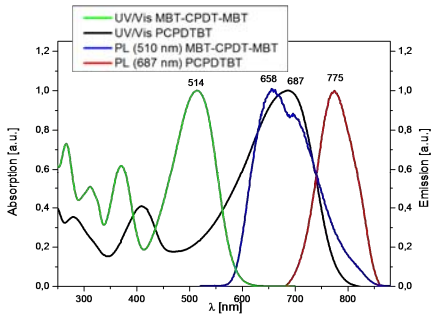
Abstract

Organic solar cells have recently been investigated intensively due to their advantages such as low cost, flexibility, and short energy payback time. To create low bandgap materials we use the donor-acceptor principle. This promissing approach allows to adjust the HOMO and LUMO energy levels of these materials what is crucial for optimized application. Within this contribution we present the synthesis and characterization of new low bandgap model oligomers and polymers. The oligomers have been used as model compounds for the corresponding copolymers.

MBT-CPDT-MBT as model oligomer for the well-known PCPDTBT



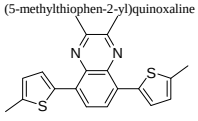
M_n = 18.000 g/mol
M_w = 31.000 g/mol



Normalized absorption & emission spectra in CH_2Cl_2

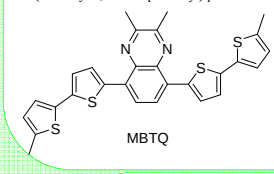
Thiophene-substituted quinoxalines

2,3-dimethyl-5,8-bis (5-methylthiophen-2-yl)quinoxaline

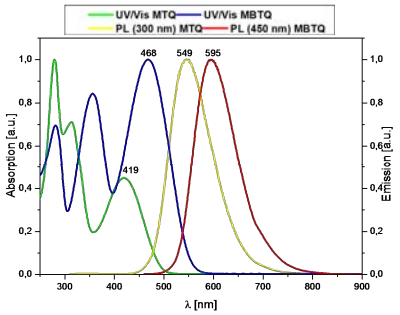


MTQ

2,3-dimethyl-5,8-bis (5'-methyl-2,2'-bithiophen-5-yl)quinoxaline



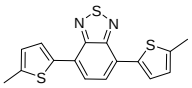
MBQ



Normalized absorption & emission spectra in CH_2Cl_2

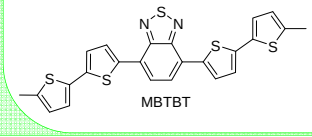
Thiophene-substituted benzothiadiazoles

4,7-bis(5-methylthiophen-2-yl) benzo[c][1,2,5]thiadiazole

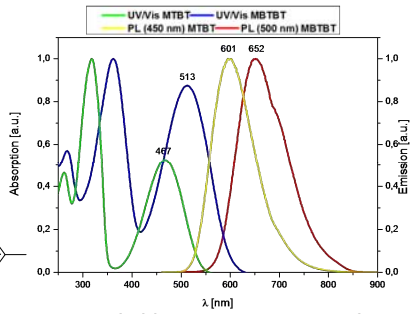


MTBT

4,7-bis(5'-methyl-2,2'-bithiophen-5-yl) benzo[c][1,2,5]thiadiazole



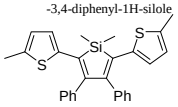
MBTBT



Normalized absorption & emission spectra in CH_2Cl_2

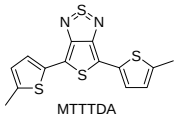
Thiophene-substituted silole, pyrazine & thienothiadiazole

1,1-dimethyl-2,5-bis(5-methylthiophen-2-yl) -3,4-diphenyl-1H-silole



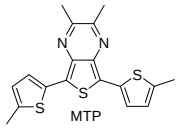
MTS

4,6-bis(5-methylthiophen-2-yl) thienothiadiazole

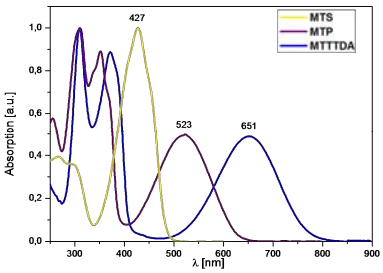


MTTTDA

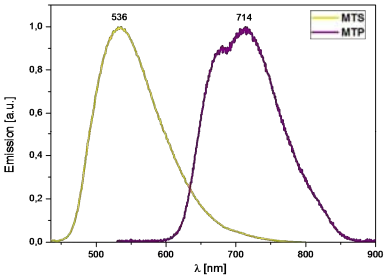
2,3-dimethyl-5,7-bis(5-methylthiophen-2-yl) thieno[3,4-b]pyrazine



MTP



Normalized absorption spectra in CH_2Cl_2



Normalized emission spectra in CH_2Cl_2

Optical properties of the oligomers

oligomer	λ_{abs}[nm]	λ_{em} [nm]	E_g [eV]
MTS	427	536	2.88
MTQ	419	549	2.81
MBTQ	468	595	2.56
MTBT	467	601	2.61
MBTBT	513	652	2.38
MTP	523	714	2.29
MTTTDA	651	no emission detected	1.92

Conclusion

- The presented materials have been synthesised and their spectral and photophysical behaviour has been studied
- The polymer **PCPDTBT** shows red-shifted long wavelength absorption maximum in comparison to the corresponding oligomer **MBT-CPDT-MBT**
- The absorption & emission maxima depend on the oligothiophene length and central building block of oligomer
- The oligomers show red-shifted long wavelength absorption maximum with increasing length of the oligothiophene substituent
- Donor-acceptor materials are potential candidates as active semiconducting layer in bulk heterojunction and bilayer organic solar cells
- Future work will be directed to synthesize new oligomers & polymers by incorporation of other building blocks