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# Effects of Solvents on Organic Field Effect Transistor (OFET) Charge Transport and Thin-Film Morphology of a High Mobility n-type Semiconducting Copolymer P(NDI2OD-T2)

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The interaction between a solvent and semiconducting polymer plays a fundamental role in the formation of thin-films that are used to fabricate solution processed organic electronic devices. Depending on this interaction, polymer chains form different aggregates in a solvent that affects film morphology and in turn, charge transport properties. To realise efficient charge transport in an organic field effect transistor (OFET), understanding the effects of solvents on film morphology is thus crucial. This study explores the effects of solvents on OFET performance and morphology of a high mobility naphthalene-diimide-thiophene based n-type semiconducting copolymer P(NDI2OD-T2) with Mn = 31.2 kDa and Đ = 2.1. In particular, six solvents have been used ranging from tolerably-good solvents such as o-dichlorobenzene to tolerably-poor solvents such as chloroform and chlorobenzene and poor solvents such as p-xylene and toluene. A direct correlation between OFET mobility with the change in solvent quality is observed where average mobility increases from less than 0.30 cm^2/Vs for samples prepared from tolerably-good solvents to ~0.55 cm^2/Vs for samples prepared from poor solvents with a maximum mobility of ~1.5 cm^2/Vs, thanks to an intermediate aggregate formation. Interestingly, when molecular orientation is probed at the top interface by Near Edge X-ray Absorption Fine Structure (NEXAFS) spectroscopy, this increase in mobility is found directly proportional with increase in backbone tilt angles with poor solvents showing more edge-on orientation, resulting an efficient intra-chain charge hopping. Atomic Force Microscopy (AFM) and Resonant Soft X-Ray Scattering (R-SoXS) were used to investigate inter-and intra-chain connectivity of polymer chains and their orientational correlations across the samples. With fibrillar microstructures ranging a few hundred nm, samples prepared from poor solvents show correlations in the order of a few microns forming an efficient interconnected microstructure. Moreover, probing local order crystallinity of thin-films with Grazing Incidence Wide Angle X-Ray Scattering (GIWAXS) experiment indicates that samples prepared from poor solvents predominantly form longer order and closely packed edge-on components compared to face-on crystallites. Taken together, improvement in the saturation mobility of P(NDI2OD-T2) samples prepared from poor solvents such as p-xylene and toluene is attributed to intermediate aggregate formation in solutions, that in turn orients polymer backbones in a predominantly edge-on registry and forms micron-long orientationally correlated microstructures.

## Keywords or phrases (comma separated)

Semiconducting Polymer, Aggregation, Morphology, Mobility > 1.5 cm^2/Vs

## Are you a student?

Yes

## Do you wish to take part in</br>the Student Poster Slam?

No

## Are you an ECR? (<5 yrs</br>since PhD/Masters)

No

## What is your gender?

Male

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