Grazing incidence diffraction on organic thin film donor-acceptor heterostructures:

Watching complex structure formation in real time

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Functional organic materials and devices are becoming increasingly complex. Their preparation and growth is, not surprisingly, similarly complex, and the resulting structure will be determined by a competition between kinetics and thermodynamics, which is not trivial to predict in particular for multi-component systems. We discuss general concepts [1] and recent examples of the thin film growth of organic semiconductors and their blends in the context of kinetic effects compared to thermodynamic (equilibrium) structure. These include unconventional structural motifs, such as a frozen-smectic structure formed in a blend of organic semiconductors, which form conventional crystals as pure compounds [2]. Particular attention is paid to the case of kinetically limited phase separation of a donor-acceptor pair (DIP:C60) used in organic photovoltaics [3,4]. This leads to asymmetric domain sizes near bottom vs top electrode due to the time (thickness) dependent phase separation with important consequences for device modeling. A further class of applications is the controlled "dilution" of pentacene by DIP or picene (PIC) to tune the charge transfer [5]. Finally, we discuss the implications for the optical and electronic properties as well as possible device applications with focus on the (generally anisotropic) coupling between donor and acceptor components in organic photovoltaics [6].

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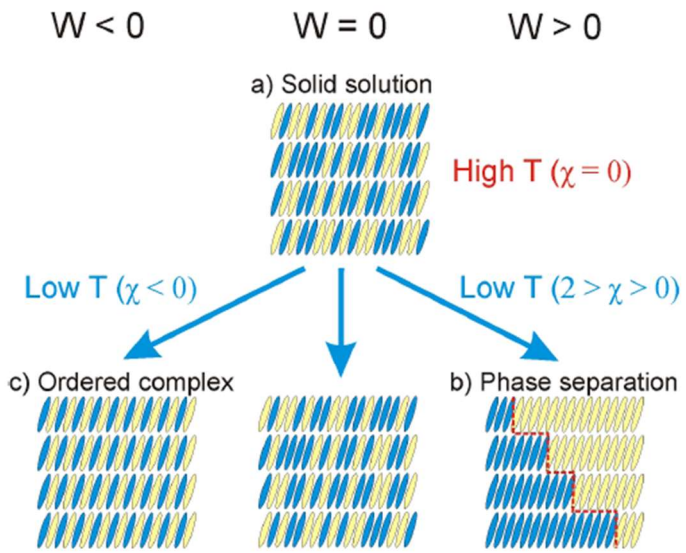

Figure 1: Simplified mean-field-theory-based schematic of possible phase behaviour in equilibrium, which is modified upon kinetically limited growth (after [1]).

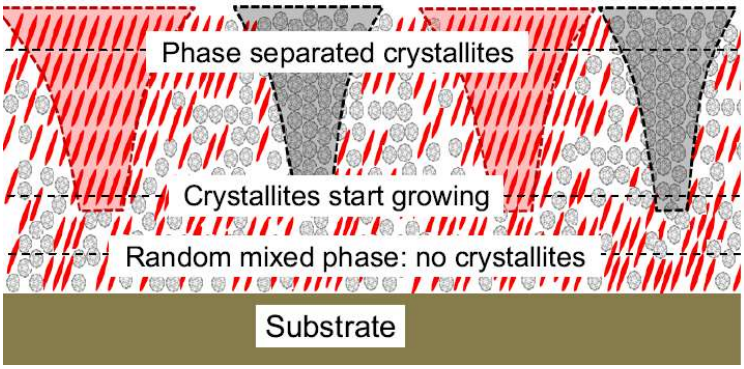

Figure 2: Schematic of non-equilibrium structure formation for a phase separating binary system (DIP:C60) (after [3]).

References

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