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EVAPORATIVE STRUCTURING OF SOLUTIONS OF ACTIVE BLENDS FOR MOLECULAR ELECTRONICS APPLICATIONS

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Many organic and hybrid thin film electronic devices (e.g. solar cells, light emitting diodes and sensors) contain a layer of a functional or responsive material based on a blend of polymeric or small-molecular components. Depending on the desired functionality, phase separation between the blend components during solution processing is desired or not. Predictive models that establish a link between processing dynamics and device performance have been highly desired to avoid trial-and-error experimentation. We study solution-stage spinodal decomposition of such blends under evaporative conditions using a combination of experimental and theoretical approaches. We provide an explanation for the decrease in the early stage spinodal wavelength under steady solvent evaporation. Scaling relations are derived that express the dependence of the emerging structure size and demixing time scale on evaporation rate. Besides giving experimental examples and summarizing our linearized theory, this contribution provides discussion on the experimental validation of the latter and in what way the dynamics change if instead of only one, two blend components are non-mass conserved. This scenario arises when water vapor condenses as a non-solvent into an evaporating polymer solution, e.g. during processing of thin-film memory elements based on multifluorinated polyhydrocarbons.

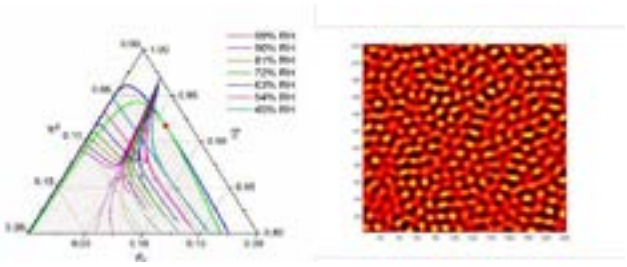

Figure 1: Left: calculated Phase diagram of a polymer/water/solvent blend with composition trajectories followed during solvent evaporation; Right: numerical simulation of spinodal decomposition of a polymer solution under conditions of simultaneous solvent evaporation and water condensation.

Recent Publications

1. **Kouijzer S et al. (2013) Predicting morphologies of solution processed polymer: fullerene blends. J. Am. Chem. Soc. 135(32):12057-12067.**
2. **Van Breemen A et al. (2015) Surface directed phase separation of semiconductor ferroelectric polymer blends and their use in non-volatile memories. Adv. Func. Mater. 25(2):278-286.**
3. **Schaefer C, van der Schoot P and Michels J J (2015) Structuring of polymer solutions upon solvent evaporation. Phys. Rev. E 91(2):022602.**
4. **Schaefer C, Michels J J and van der Schoot P (2016) Structuring of thin-film polymer mixtures upon solvent evaporation. Macromolecules. 49(18):6858-6870.**
5. **Sharifi Dehsari H, Michels J J and Asadi K (2017) Processing of ferroelectric polymers for microelectronics: from morphological analysis to functional devices. J. Mater. Chem. C. 5(40):10490-10497.**

Biography

Jasper Michels completed his PhD at the University of Twente (The Netherlands) in at the Supramolecular Chemistry and Technology group of Professor D N Reinhoudt, where he received his PhD Degree in 2001. After his graduation he held a Postdoctoral Research position for two years in the group of Professsor H L Anderson at Oxford University, UK. In 2003 he started working at TNO Science and Industry in Eindhoven, to join Holst Centre in 2006 as a Senior Scientist. In the period 2006-2016 he has been member and vice-chairman of the advisory board for IOP Self-Healing Materials program in The Netherlands. In September 2014 he joined the Department of Molecular Electronics at the Max Planck Institute for Polymer Research as a Group Leader. His research activities include modeling and simulation of phase transitions in semiconducting thin films that find applications in organic and hybrid electronics.

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