



VII Encuentro Argentino de Materia Blanda

Process-directed self-assembly

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In a thin film, copolymers self-assemble into a variety of nanoscale structures that do not necessarily have analogs in the equilibrium phase diagram but are dictated by the kinetics of structure formation [1]. In fact, the free-energy landscape of these systems is rugged [2], featuring a multitude of metastable structures [3]. Process-directed self-assembly refers to structure transformations that reproducibly trap the kinetics of structure formation that ensues after a sudden change (“quench”) of the thermodynamic state into a desired, (meta)stable target state [1]. Such thermodynamic processes include *inter alia* control of global thermodynamic parameters, such as temperature, pressure or tension, as well as localized stimuli such as chemical reactions or, in biological systems, the action of membrane proteins that exert local forces.

Copolymer materials are ideal model systems to explore how one can deterministically direct the assembly of multicomponent polymer systems because the time scales of collective structure changes are large and experimentally accessible and, additionally, an accurate mean-field description (self-consistent field theory, SCFT) for equilibrium properties and metastable structures is available.

In this talk I will discuss the differences between the equilibrium phase diagram and the diagram of kinetically accessible states after a quench and illustrate various applications [3,4,5]. I will discuss how the subdiffusive dynamics of polymers influences the short-time kinetics [6] and illustrate to what extent this information suffices to predict metastable intermediates, such as the stitch morphology [5], in the course of directed self-assembly.

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[3] Process-accessible states of block copolymers, Sun, D.W., Müller, M. *Phys. Rev. Lett.* **2017**, 118, 067801

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[6] Collective short-time dynamics in multicomponent polymer melts, Wang, G., Ren, Y., Müller, M., *Macromolecules* **2019**, 52, 7704

