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CoLiSA.MMP

Computational Lithography for Directed Self-Assembly: Materials, Models and Processes

General description

Directed self-assembly (DSA) of block copolymers is one of the most promising techniques to enable the continuing miniaturization of integrated circuits (IC) and to advance ”More Moore” applications. It combines top-down photolithography for the creation of guiding patterns with engineered new materials and processes to facilitate cost-efficient bottom-up techniques for pattern density multiplications and defect rectifications. An industry scale application of DSA still faces two challenges: i) The host substrate heavily impacts DSA. The resulting pattern formation needs to be well understood and modeled in order to optimize its efficiency and avoid defects. ii) The specific properties of DSA must be considered early in the design process.

Goals / Objectives

- Development of new material and process models and a computational lithography framework for DSA.
- Combination of existing and new, specially designed atomistic and coarse-grained models with experimental data to develop and calibrate efficient and predictive reduced models.
- Use of new modeling capabilities to establish new design flows which include the lithographic generation of guiding patterns and the resulting patterns after DSA .
- Prediction of lithographically manufacturable guiding patterns and process conditions for given target structures.

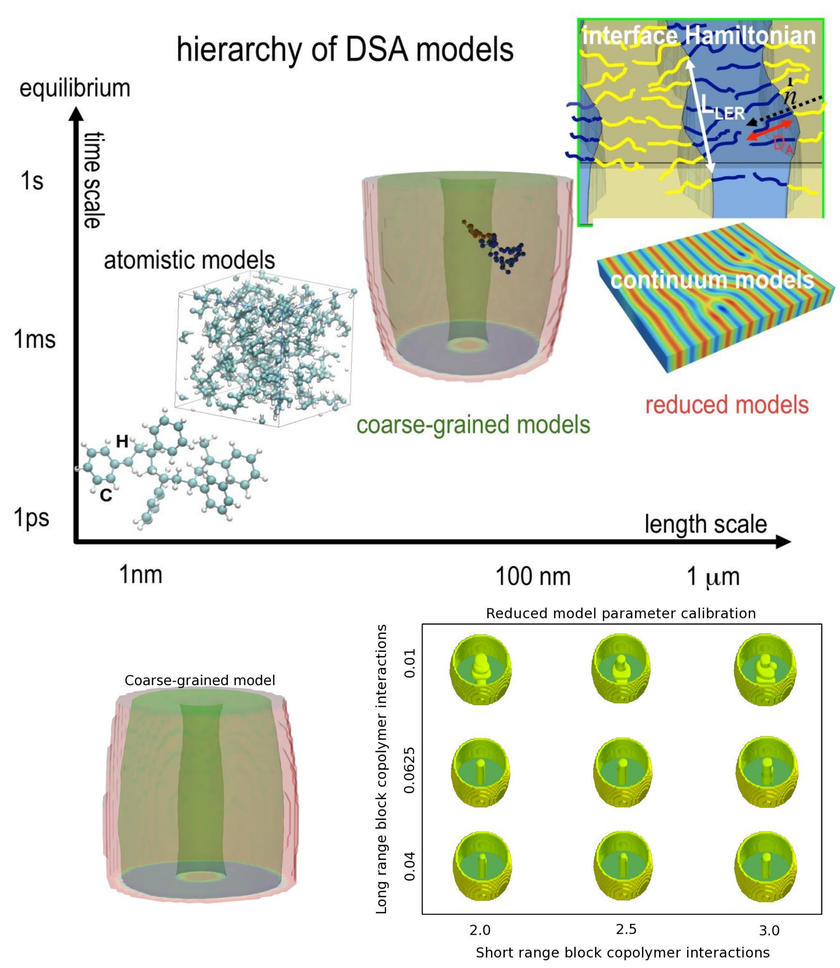
Societal impact / Results

The cooperation between partners makes a contribution to the state of the art of DSA in the field of both science and technology.

- New advanced block copolymers for DSA allowing for 20 nm structures were synthetized.
- Thermodynamical conditions for rapid defect annihilation and ordering of block copolymers were determined.
- Graphoepitaxial contact hole shrinking and chemoepitaxial density multiplication processes were implemented.
- Atomistic models have been involved to estabilish the connection between the chemical structure of block copolymers and coarse-grained models.
- The software infrastructure was designed in order to seamlessly integrate DSA models with the lithographic simulation process. First test cases were carried out.

Looking ahead

By enhancing existing and future lithographic patterning techniques, DSA of block copolymers can help to further extend the impressive development in semiconductor technologies. Cost-efficient technologies for the miniaturization of patterns in semiconductor devices are key to the development of more powerful computers, mobile devices and many other types of consumer and industrial electronics.



Partners

- Fraunhofer Institute for Integrated Systems and Device Technology (IISB)
- Arkema France SA
- Agencia Estadal Consejo Superior de Investigaciones Científicas (CSIC)
- Université de Bordeaux 1 (LCPO)
- Commissariat à l’Energie Atomique et aux Energies Alternatives (LETI)
- National Technical University of Athens (NTUA)
- Georg-August-Universität, Göttingen, Stiftung Öffentlichen Rechts

Countries involved

- France
- Germany
- Greece
- Spain

Publications

- T. Fühner, U. Welling, M. Müller and A. Erdmann: "Rigorous simulation and optimization of the lithography/directed self-assembly co-process," Proc. SPIE 9052 (2014) 90521C
- W. Li, P.F. Nealey, J.J. de Pablo and Marcus Müller: "Defect Removal in the Course of Directed Self-Assembly is Facilitated in the Vicinity of the Order-Disorder Transition," Phys. Rev. Letters 113 (2014) 168301

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