Diffusion-limited interface collisions

Marguet[1] & Pierre-Louis[1]

[1] Institut Lumière Matière, UMR5306 Université Lyon 1-CNRS, Université de Lyon 69622 Villeurbanne, France
[2]

bastien.marguet@univ-lyon1.fr

In many growth processes, two-dimensional domains are nucleated, grow, and finally merge. This scenario can be found in diverse non-equilibrium processes, such as the quenching of magnetic systems[1], epitaxial growth of molecular or atomic monolayers[2], or growth of bacterial colonies[3]. While nucleation and growth have been studied extensively, less is known about the merging process. In order to investigate this process, we study in details the collision of two straight interfaces moving in opposite directions. When the interfaces interact only with short-range interactions[4], the interface which is formed by the collision was recently found to be asymptotically independent on the collision details (type of interaction, fluctuations during the collision, etc...). As a consequence, despite the complex nonlinear character of the collision process, simple universality emerges.

We focus on the case where interactions are induced by diffusing species, such as during the growth of two-dimensional materials (such as graphene), or during the growth of bacterial colonies competing for food. We use on-lattice Kinetic Monte Carlo Simulations and find that a Langevin model can reproduce the main results. As opposed to the intuitive expectations, we find that the roughness of the newly formed interface can be smaller when growth is faster. These results could help to minimize the roughness of grain boundaries of grown 2D materials, which have a strong influence on the thermal and electronic transport properties of these materials.

Références

1. Krusin-Elbaum, L and Shibauchi, T and Argyle, B and Gignac, Lynne and Weller, Dieter, *Stable ultrahigh-density magneto-optical recordings using introduced linear defects*, Nature, pages 444-6, Apr 2001, doi : 10.1038/35068515
2. Gao, Li and Guest, Jeffrey R. and Guisinger, Nathan P., *Epitaxial Graphene on Cu(111)*, Nano Letters, Volume 10, number 9, pages 3512-3516, 2010, doi.org/10.1021/nl1016706
3. Be'er A, Zhang HP, Florin EL, Payne SM, Ben-Jacob E, Swinney HL., *Deadly competition between sibling bacterial colonies*, Proc Natl Acad Sci USA, Jan 2009
4. Aarão Reis, F. D. A. and Pierre-Louis O., *Interface collisions*, Phys. Rev. E, Apr 2018, American Physical Society