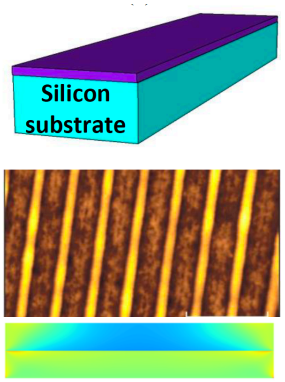
Post-doctoral position
Theoretical condensed matter: crystal growth on patterned substrates

IM2NP (Marseille) / INSP (Paris)
Duration: 18 months (expected to start in 2024)



The understanding and control of crystal growth is of major importance in the production of new technologies. This is case for the development of new transistor geometries relevant for CMOS devices. Of particular interest is the control of strain by geometry, and its influence on the film morphologies.

This theoretical post-doc aims at providing a dynamical analysis of the self-organization of heteroepitaxial films on patterned substrates. It focuses on strain-sharing and finite-size effects and their influence on the morphological and structural evolution induced by surface diffusion. The applicant will develop a theoretical modelization that accounts for the long-range elastic interactions, both using analytical resolution and finite-element methods amenable to describe unconventional geometries. Dynamical analysis will be performed in the surface diffusion partial differential equations framework, possibly within the non-linear regime.

More in detail, the aim is to study elastic relaxation in film/mesa structures as a function of various parameters. The post-doc will analyze the influence of geometry, based on the analytical solution of elasticity by the Airy function method [1]. In particular, he/she will consider the influence of the interfaces, which will be described with several assumptions (fixed displacement or mean effective relaxation). He/she will compare the predictions of the elastic calculation with the results obtained by STMicroelectronics and the HR-STEM characterizations carried out. The influence of the structure's geometry, its aspect ratios, stress sharing, and the effect of the composition of the SiGe film obtained by condensation will also be considered. Potentially, the coupling between finite-size effects in the two horizontal directions of the pattern will be investigated by Fourier transformation of the Airy function. Elastic relaxation will be extensively analyzed and the optimum relaxation conditions determined to enable epitaxial recovery.

We will also consider to a constrained system with a membrane-like geometry. The characteristic buckling length of the film will be determined as a function of effective stress. For that, linear analysis of the buckling instability under stress will be performed and the results will be compared to the bulk case and to experimental results before and after annealing.

The applicant will both develop analytical and numerical tools to describe the systems under experimental industrial study, as part of a theoretical / experimental / industrial collaboration.

Skills :
Applicants should hold a recent PhD degree in condensed matter and/or statistical physics, and should have strong analytical and computational skills.

Keywords :
Crystal growth, hetero-epitaxy, elasticity, finite-element methods, dynamical analysis, numerical and analytical methods

To apply, contact Isabelle Berbezier or Jean-Noël Aqua
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https://www.im2np.fr/fr http://www.insp.jussieu.fr/-Aqua-Jean-Noel-.html

[1] *Morphological Relaxation of Strained Epitaxial Films for Stripe- Geometry Devices*. K. R. Hannikainen, F. Deprat, O. Gourhant, I. Berbezier, J.-N. Aqua, Advanced Materials Technologies, **DOI:** 10.1002/admt.202301655