Dewetting dynamics of crystalline thin films

Bussmann, E.,[1] Passanante, T.,[1] Cheynis, F.,[1] Leroy,F.,[1] Pierre-Louis,O.,[2] and Muller,P.[1]

[1] *CNRS, Aix-Marseille Université, CINaM UPR 3118, Campus de Luminy, Case 913, 13288 Marseille Cédex France*

[2] *Université de Lyon I, LPCMN, 69622 Villeurbanne Cédex, France*

Thin solid films are the basic components in many devices. However since the deposition conditions generally are far from equilibrium, such 2D thin films, when annealed, may break up into 3D islands. Such a dewetting process is observed in many experimental systems. If a continuous film is required for applications, its dewetting clearly is a parasitic process but it could also be considered as a method to produce and control the formation of an assembly of nanocrystals. Here we report a quantitative characterization of the dewetting dynamics of silicon-on-oxyde (SOI) thin-films. From an experimental point of view we use low-energy electron microscopy to record real-time in-situ movies of the dynamics of the SOI dewetting process leading to the formation of 3D compact Si nanocrystals. The complex morphological evolution is reproduced by a simple Solid-on-Solid Kinetic Monte Carlo model in which enters only two physical ingredients: a wetting parameter and a reduced temperature. We also develop illustrative models that captures the essentials of the underlying physics that enable us to clearly identify the origin of the driving-force. Our results show (i) that the dewetting is a consequence of surface-free-energy-minimization mediated by surface diffusion and (ii) that the velocity of the dewetting front is limited by its thickening. We connect the rim growth mechanism to the growth dynamics of the dewetted area. The front edges instabilities that lead to the formation of local elongated structures (then to 3D islands by a pinch-off process) are closely connected to the local height instabilities of the rim. Finally the dewetting properties of SOI films are compared to those obtained for a few other systems.