Equilibrium size distribution of one-dimensional surface clusters: scaling properties, influence of elastic-like relaxation and fracture process

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The length distribution of one-dimensional atomic rows self-assembled on a crystal surface in thermal equilibrium at low coverage is calculated both in the framework of an analytical theory[1] and with the use of the Monte Carlo simulations. In the case of interatomic interactions restricted to nearest neighbor atoms the distribution exhibits the scaling properties formally similar to those found in the theories of irreversible growth. The difference consisted in the behavior of the scaling functions which in the equilibrium case was monotonously decreasing while in the case of irreversible growth exhibits a monomodal character. We found that our scaled distribution described without any fitting parameters the monotonous distributions recently observed in the growth of Ga rows on Si(001) by Albao et al. [Phys. Rev. B **72**, 035426 (2005)] [2]. Elastic effects are supposed to play a key role in the strained epitaxy. As an example the statistical distributions of sizes of the chains of Ag atoms self-assembled on the steps of a vicinal Pt surface as established experimentally and calculated within a lattice gas model by Gambardella et al. [Phys. Rev. B 73, 245425 (2006)] is discussed. It is suggested that the discrepancy between the theory and experiment may be due to additional interatomic interactions inside the clusters .

Finally the fracture process occuring during the epitaxial process is studied. It is argued that in large strained monolayer-high islands the most weakly bound could be the interior atoms furthest from the island boundaries. This means that at elevated temperatures the detachment of atoms from the islands could start in their interiors and not at the boundaries as the bond counting arguments would suggest. This may lead to the island fracture. The growth kinetics were simulated with a simple 1+1 dimensional model. Bimodal island size distributions and N-shaped temperature dependence of the total number of islands similar to those observed in metal heteroepitaxy were found .

[1] V.I. Tokar and H. Dreyssé, Phys. Rev B **68** (2003) 195419; Phys. Rev. E **68** (2003) 011601; Phys. Rev. E **72** (2005) 031604; Rev B **72** (2005) 035438

[2] V.I. Tokar and H. Dreyssé, Phys. Rev B **74** (2006) under press