

On stability of self-assembled nanoscale patterns

Shaowen Hu^{a,1}, Girish Nathan^b, Fazle Hussain^c,
Donald J. Kouri^{a,b,d}, Pradeep Sharma^{b,c,*},
Gemunu H. Gunaratne^{b,e,*}

^a*Department of Chemistry, University of Houston, Houston, TX 77204, USA*

^b*Department of Physics, University of Houston, Houston, TX 77204, USA*

^c*Department of Mechanical Engineering, University of Houston, Houston, TX 77204, USA*

^d*Department of Mathematics, University of Houston, Houston, TX 77204, USA*

^e*The Institute for Fundamental Studies, Kandy, Sri Lanka*

Received 17 August 2006; received in revised form 22 December 2006; accepted 15 January 2007

Abstract

We conduct linear and nonlinear stability analyses on a paradigmatic model of nanostructure self-assembly. We focus on the spatio-temporal dynamics of the concentration field of deposition on a substrate. The physical parameter of interest is the mean concentration C_0 of the monolayer. Linear stability analysis of the system shows that a homogeneous monolayer is unstable when C_0 lies within a band symmetric about $C_0 = \frac{1}{2}$. On increasing C_0 from zero, the homogeneous solution destabilizes to a hexagonal array, which then transitions to stripes. Transitions to and from the hexagonal state are subcritical. Square patterns are unstable for all values of C_0 transitioning either to hexagons or stripes. Further, we present stability maps for striped arrays by considering possible instabilities. The analytical results are confirmed by numerical integrations of the Suo-Lu model. Our formalism provides a theoretical framework to understand guided self-assembly of nanostructures.

© 2007 Elsevier Ltd. All rights reserved.

Keywords: Self-assembly; Stability analysis; Nanostructures
