On nonlinear surface growth models

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- Title: Self-organization of nanostructures on surfaces
- Period: 2015-2016

Participants

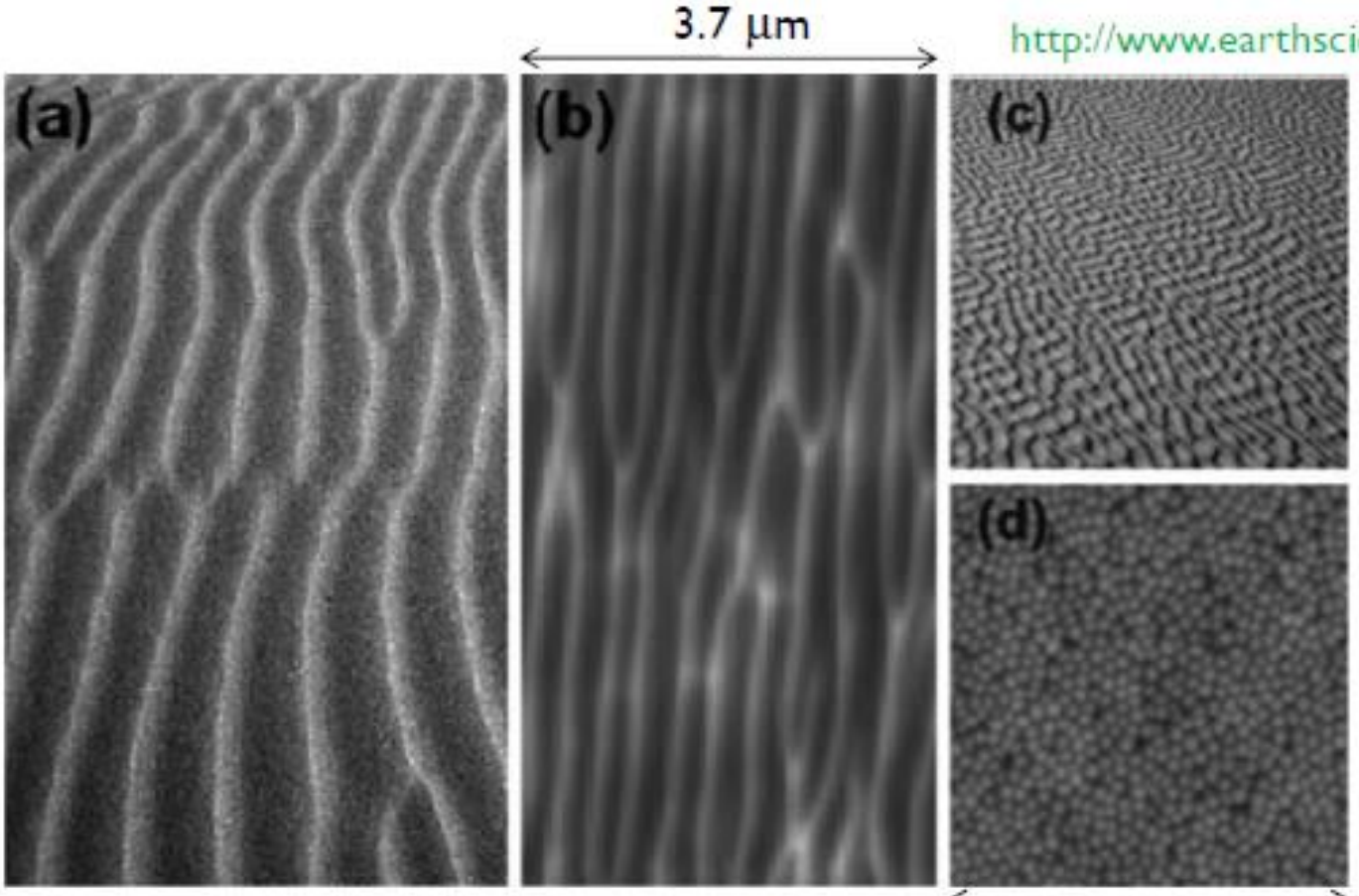
- Hungarian (5): **University of Miskolc, Institute of Machine and Product Design** (1 prof., 1 postdoc, 1PhD st.), HAS Wigner Research Institute (1 res.), University of Pécs (1 prof.)

- French (7): **Université de Picardie Jules Verne, Amiens; LPMC (**Laboratoire de Physique de la Matière Condensée**),** LAMFA (Laboratoire Amiénois de Mathématique Fondamentale et Appliquée) (4 prof., 1 assoc. prof., 2 PhD st.)

Content

- • Surface patterns
- • Growth Models
- • Analytical results
- • Numerical solutions
- • Surface roughness test

Surface patterns



http://www.earthscienceworld.org/images

Formations on sand dunes, NM

0.7 keV Ar^+ / GaSb dots (θ=0)

(b,d) courtesy R. Gago & L.Vázquez

Formations on sand dunes, Morocco

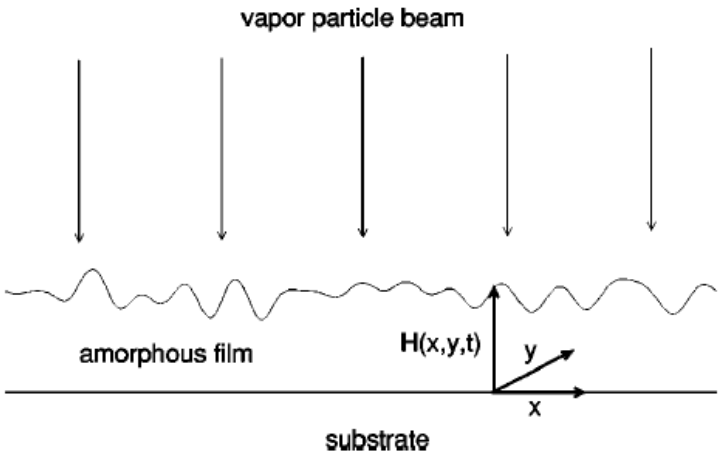
Si ripples (Ar^+ plasma)

Growth of thin amorphous films

- Challenge: exploring the relationship between the structure and the properties of nanostructured materials
- Developing nanoscale structures in a conscious, designed way
- Model level tests (small size!)
- Application: creating various thin layers on a solid substrate
- Deposition techniques: IBS, MBE, CVD, PVD, ...

Model of amorphous thin film growth

Develop models to predict atomistic processes, to able to control and manipulate the film structures to achieve desired properties



height profile $h(x,y,t) = H(x,y,t) - Ft$

Time evolution of the surface morphology

$$\boxed{h_t = G(\nabla h) + \eta}$$

G: functional - experimental setup, details of kinetics, deposition process

F: the mean deposition rate

η: deposition noise

Outcomes:

Presentations at national conferences: 6

at international conferences: 5

Publications: 7

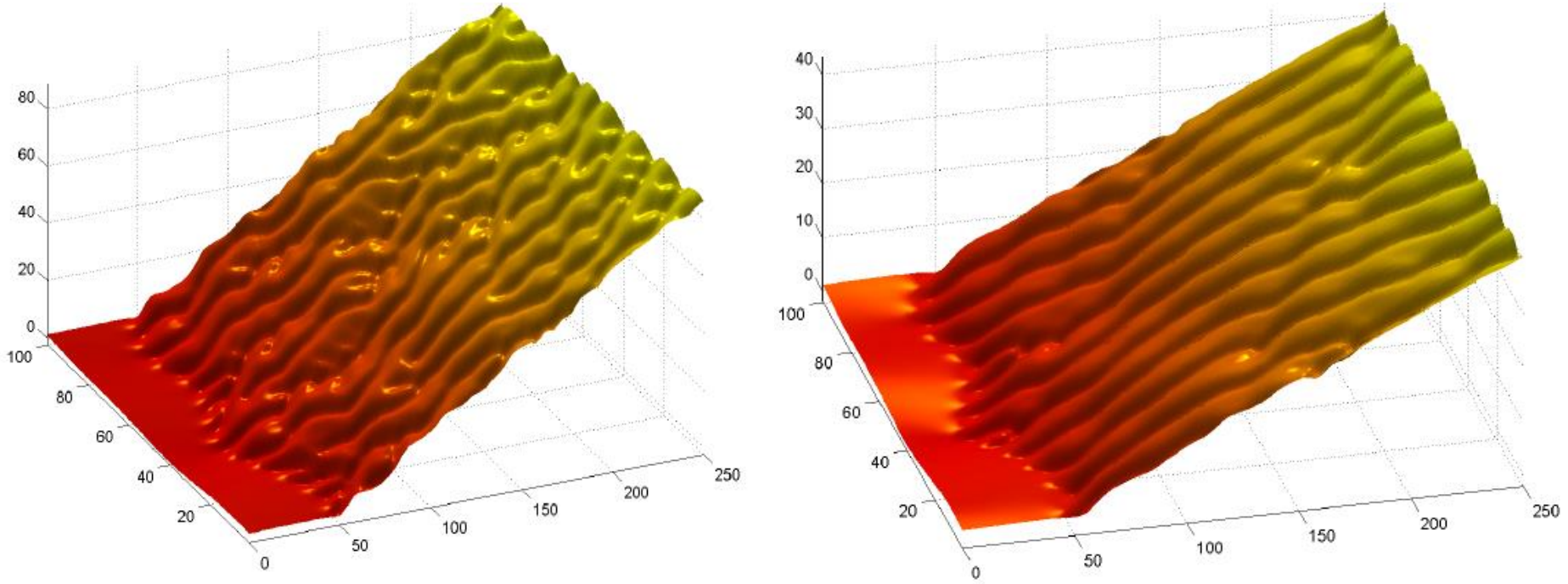
conference papers: 4

scientific journal papers:3 (2 with IF)

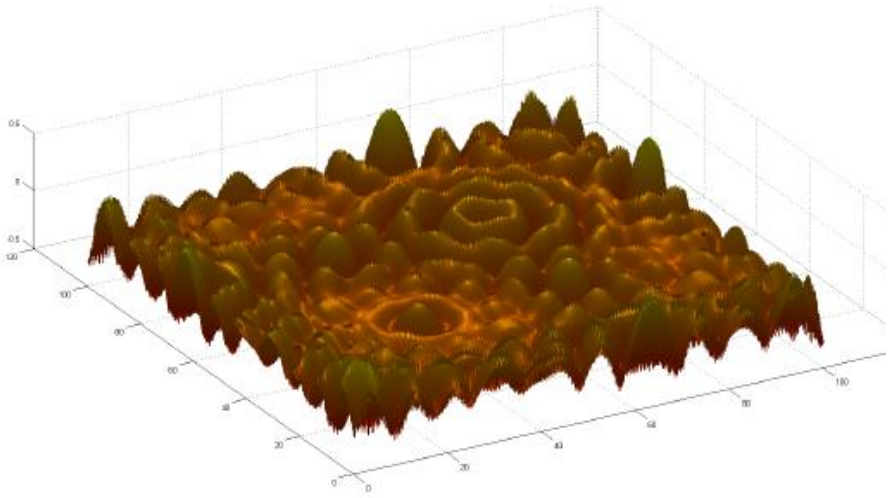
Numerical results

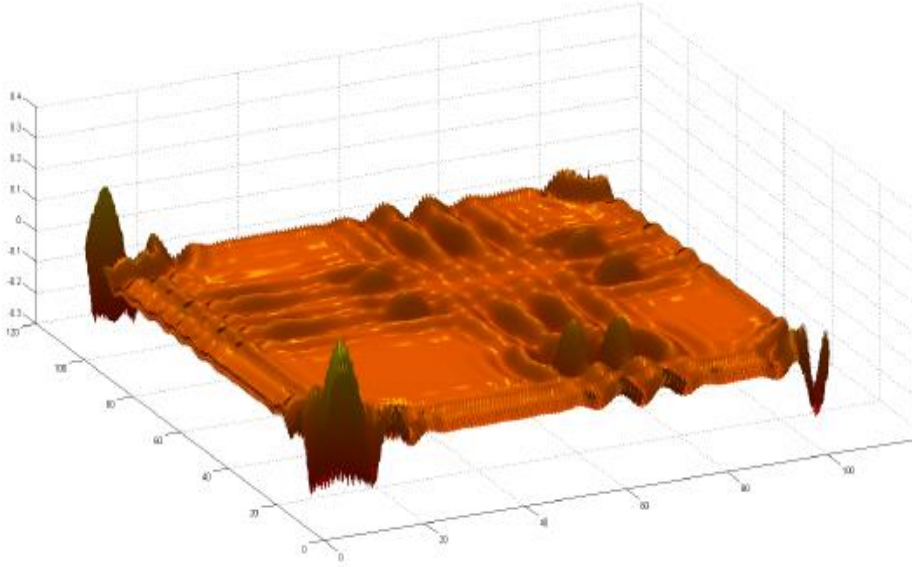
The one-dimensional and two-dimensional Conserved Kuramoto-Sivashinsky equation are solved with using Fourier spectral collocation in space and

the fourth order Runge-Kutta exponential time differencing scheme for time discretization.



1+1 dimension

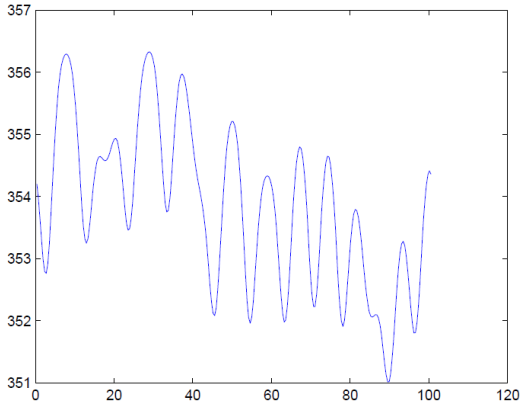




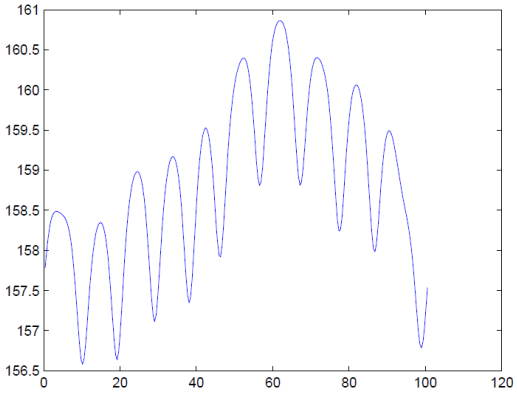
1+2 dimensions

Height profiles at T=1000 for

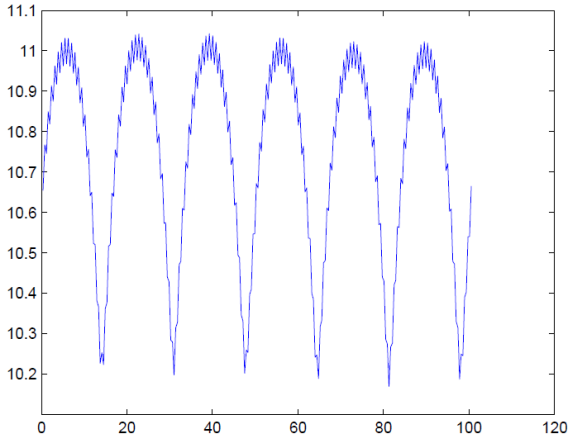
r=0.01



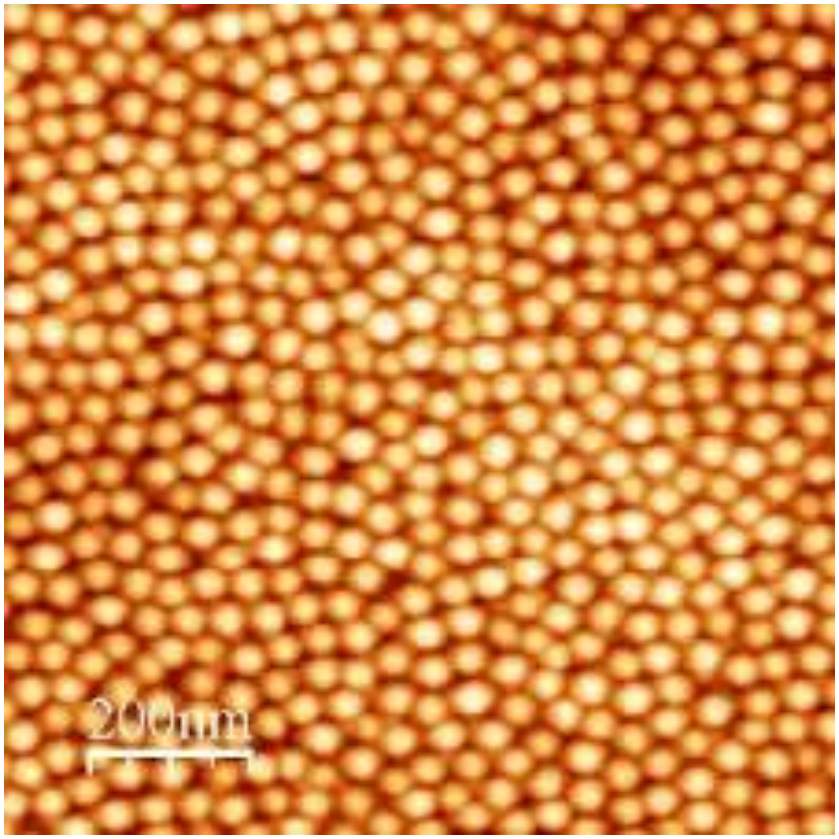
r=0.5

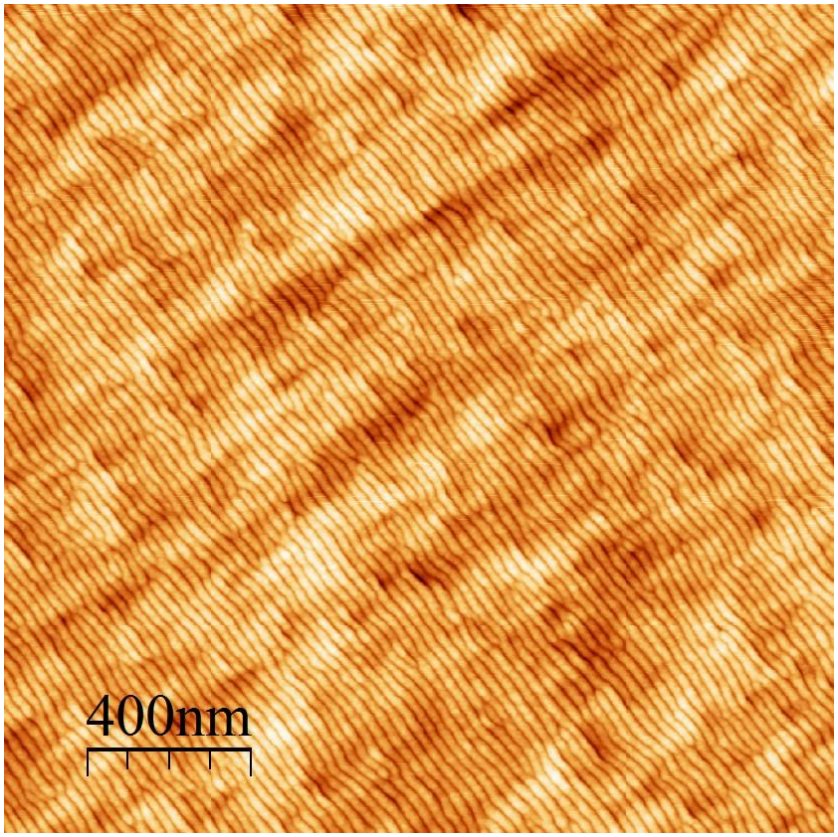


r=10



Experiments





How the physical parameters affect on the surface morphology?

The afterlife of the project

- 2 theses have been defended
- University of Miskolc: 1 PhD student (El Khalil Chiliah) started his PhD studies on roughening of self-organized surfaces
- Université de Picardie Jules Verne: 2 PhD students are working on deposition technique modelling
- Common research proposal has been submitted

Thank you for your kind attention!

Je vous remercie de votre aimable attention!