

TM
M39/r



MATERIALS SCIENCE & ENGINEERING

R

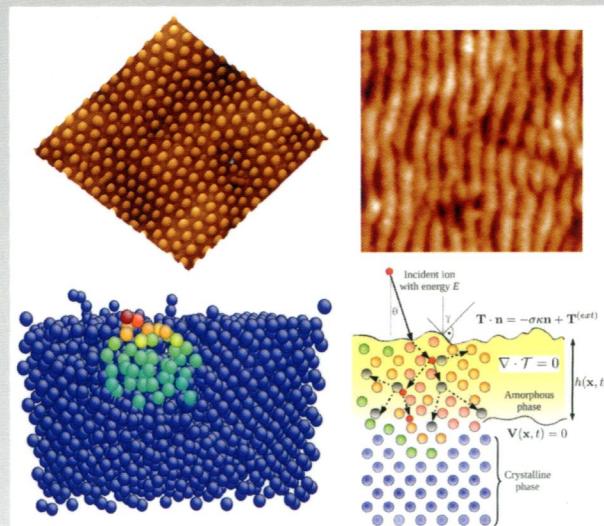
Reports: A Review Journal

Editor-in-Chief:
Franky So

Guiding Editor:
Michael Nastasi

Self-organized nanopatterning of silicon surfaces
by ion beam sputtering

Javier Muñoz-García, Luis Vázquez, Mario Castro,
Raúl Gago, Andrés Redondo-Cubero,
Ana Moreno-Barrado, Rodolfo Cuerno



Self-organized nanopatterning of silicon surfaces by ion beam sputtering

J. Muñoz-García^{a,*}, L. Vázquez^b, M. Castro^c, R. Gago^b, A. Redondo-Cubero^d, A. Moreno-Barrado^c, R. Cuerno^a

^aDepartamento de Matemáticas and GISC, Universidad Carlos III de Madrid, E-28911 Leganés, Spain

^bInstituto de Ciencia de Materiales de Madrid (CSIC), Cantoblanco, E-28049 Madrid, Spain

^cGrupo de Dinámica No-Lineal and Grupo Interdisciplinar de Sistemas Complejos (GISC), Escuela Técnica Superior de Ingeniería (ICAI), Universidad Pontificia Comillas, E-28015 Madrid, Spain

^dDepartamento de Física Aplicada, Universidad Autónoma de Madrid, Cantoblanco, E-28049 Madrid, Spain

Contents

1. Introduction	2
2. Historical overview	3
3. Experimental results	5
3.1. Impurity-free patterning	5
3.1.1. Low-energy (<10 keV)	5
3.1.2. Medium-energy (10–200 keV)	10
3.2. Patterning with simultaneous impurity incorporation	12
3.2.1. Isotropic patterns: nanodot/nanohole patterns	12
3.2.2. Anisotropic patterns: nanoripples	18
3.2.3. Mechanisms for IBS patterning with metal co-deposition: systematic studies	23

* Corresponding author.

E-mail addresses: javiermunozgarcia@gmail.com (J. Muñoz-García).

The publisher encourages the submission of articles in electronic form thus saving time and avoiding rekeying errors. A leaflet describing our requirements is available from the publisher upon request

4. Atomistic simulations	25
4.1. Physical mechanisms involved in IBS	25
4.1.1. Mechanisms related to ion damage.....	25
4.1.2. Mechanisms related to material relaxation.....	26
4.2. Overview of numerical simulation methods for IBS.....	27
4.3. Historical account of simulation results.....	27
4.3.1. Early works: comparison between methods.....	27
4.3.2. Amorphization and annealing after irradiation.....	27
4.3.3. Atomistic simulations in the context of surface nanopatterning theories.....	28
4.3.4. From MD to continuum models (crater function approach)	29
5. Continuum models.....	30
5.1. Early theories of IBS surface nanopatterning	30
5.1.1. Geometric methods based on the sputtering yield.....	30
5.1.2. The Bradley–Harper theory.....	31
5.1.3. Refinements of Bradley-Harper theory.....	32
5.2. Two-field models of IBS nanopatterning	33
5.2.1. Two-field models for single-component systems.....	33
5.2.2. Two-field composition models.....	35
5.3. Stress-driven hydrodynamics of irradiated silicon targets	37
6. Applications	39
7. Concluding remarks.....	41
Acknowledgements.....	41
References	41