

# Instability and Patterning of Thin Polymer Films - Video course

## COURSE OUTLINE

This course will expose students to the science of sub-micron, meso and nanoscale patterning of surfaces with special emphasis on thin soft films like gels, polymers etc.

The course will focus on the different classes of thin film patterning techniques like the top down techniques (lithography), bottom up techniques (self assembly and self organization) as well as combination of the two (confined and template guided self organization) as well as focus on various engineering applications of the patterned thin films like super wetting and super hydrophobicity, structural color, metamaterials, super adhesives and easy release coatings, microfluidics etc.

The course will be expose the students to the various soft lithography techniques and will focus on how hydrodynamics and capillarity plays and intriguingly critical role in evolution and pattern formation.

State of art concepts like "patterns on demand", "reconfigurable structures", "patterning beyond the master", "patterning of non planar surfaces", "pattern miniaturization by shrinkage" etc. will also be covered in the course.

## Contents:

1. General Introduction to Patterning; Lithography Techniques, Applications of Patterned thin films.
2. Classification of Patterning Techniques: Top Down, Bottom up, combined

# NPTEL

<http://nptel.iitm.ac.in>

## Chemical Engineering

### Pre-requisites:

Basic Knowledge of Fluid Mechanics, Elementary knowledge of Physics and Chemistry.

### Additional Reading:

Current Issues of Advanced Materials, Langmuir, Nature Materials, Nano Letters.

### Hyperlinks:

1. [www.en.wikipedia.org/wiki/Soft\\_lithography](http://www.en.wikipedia.org/wiki/Soft_lithography)
2. [www.hyperphysics.phy-astr.gsu.edu/hbase/HFrame.html](http://www.hyperphysics.phy-astr.gsu.edu/hbase/HFrame.html)

### Coordinators:

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techniques; Serial vs. Parallel Techniques.

3. Soft Lithography: basics, key concepts, major techniques - Micro Contact Printing, Nano imprint Lithography, Hot Embossing, Replica Molding (REM), Micro Molding in Capillaries (MIMIC), Capillary Force Lithography (CFL), Polymer Bonding Lithography; Patterning of films coated on Curved Surfaces.
4. Soft Lithography for patterning of inorganic (sol-gel) thin films and Hydrogels.
5. Hydrodynamics of a free surface, Capillarity, Physical origin of Instability, Wetting and dewetting, Length Scales Analysis, Pattern Formation.
6. Ordered pattern formation by template guided and confined dewetting, Dewetting of Bilayers
7. Elastic Contact Instability: concepts, governing equations, Elastic contact Lithography, Pattern Miniaturization in Bilayers, Adhesive Force Assisted Imprinting.
8. Electric Filed and Thermal gradient induced patterning, Electrohydrodynamics, LISA (Lithographically Induced Self Assembly).
9. Stress Engineering.
10. Multi scale patterning.
11. Applications of Patterned Thin Films: Super Hydrophobic and Super Wetting Surfaces, Structural Color, Super Adhesives and Easy Release Coatings, Micro Fluidics etc.

## COURSE DETAIL

S.No	Topics	No. of Hours
1	Introduction to the Topic.	1

2	<ol style="list-style-type: none"> <li>1. Different Concepts of Patterning.</li> <li>2. Top Down and Bottom up Techniques.</li> <li>3. Serial vs. Parallel Techniques.</li> <li>4. Basics of Photolithography.</li> </ol>	2
3	Introduction to Soft Lithography.	1
4	<ol style="list-style-type: none"> <li>1. Different Soft Lithography Techniques.</li> <li>2. Nano Imprint Lithography, Micro Contact Printing, REM, MIMIC, CFL etc.</li> </ol>	7
5	Soft Lithographic Patterning of Curved Surfaces.	1
6	Soft Lithography on Inorganic Gels and Hydrogels.	1
7	Hydrodynamics of a Free Surface, Capillarity, Length Scale Analysis.	6
8	Dewetting based patterning.	1
9	Pattern Directed and Confined Dewetting.	3
10	Dewetting of Bilayers.	2

11	Contact Instability in Elastic Films, Surface Evolution, Morphological Transformation of Patterns.	3
12	Elastic Contact Lithography.	2
13	Pattern Miniaturization with Elastic Bilayers.	1
14	Adhesive Force assisted Imprinting.	1
15	Fundamentals of Electrohydrodynamics.	1
16	Electric Field induced patterning, length scale, Pattern morphology control, Bilayers.	4
17	Stress Induced Patterning, Spontaneous Wrinkles Creation of Fractals.	2
18	Specific Applications of Patterned Surfaces: -	
	Super Wetting, Super Hydrophobicity.	1
	Super Adhesive, Easy Release Coating.	1
	Patterned Surface in Microfluidics, Lab on a Chip.	1
	Structural Colors and other	1

applications.	
<b>Total</b>	43

**References:****Text Book:**

1. "Alternative Lithography", C. M. Sotomayor Torres (Ed.), Kluwer Academic Press, 2003.
2. "Nanoscale Science and Technology", Robert Kelsall, Ian Hamley and Mark Geoghegan, Wiley, 2007.

**Reference Book/ Materials:**

1. Y. Xia and G. M. Whitesides, "Soft Lithography" Angew. Chem. Int. Ed. 37, 550, 1998.
2. R. Mukherjee and A. Sharma, "Self-Organized Mesopatterning of Thin Polymer Films", Encyclopedia of Nanoscience and Nanotechnology, Second Edition, American Scientific Publishers.