Colloidal Nanolithography of Antenna Arrays

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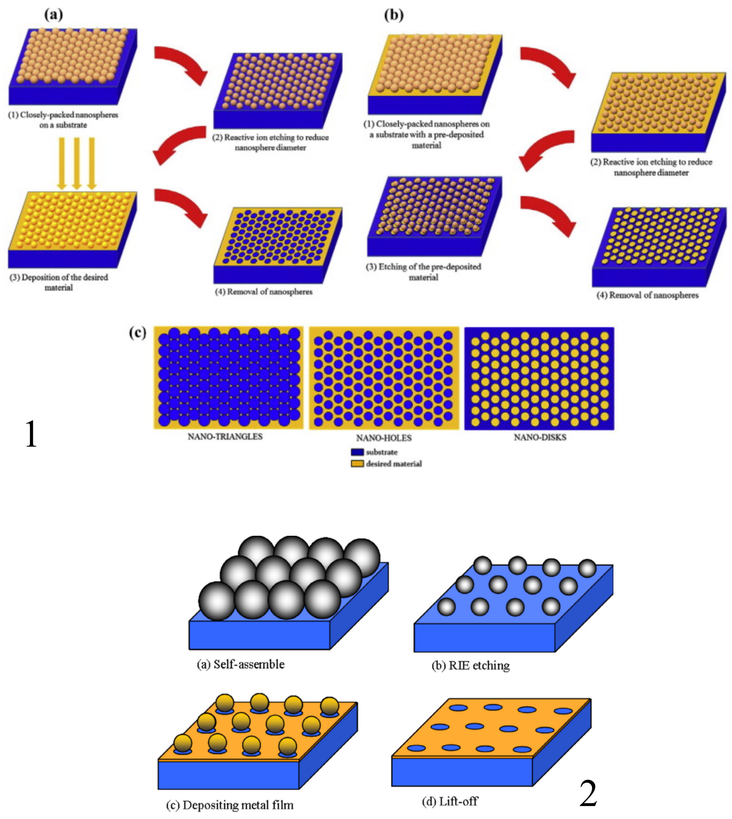
PURE PROGRAM FOR UNDERGRADUATE RESEARCH

NANOSPHERE LITHOGRAPHY



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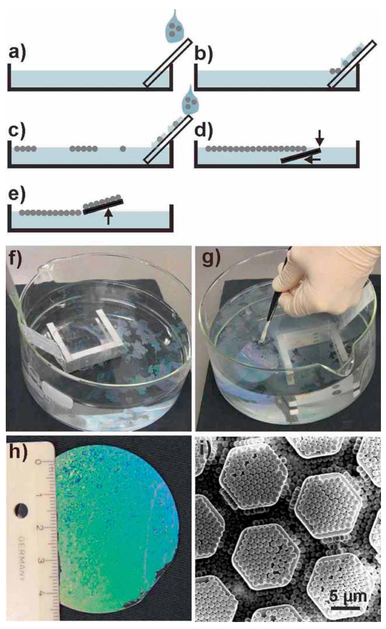

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"A Convenient Method to Produce Close- and Non-close-Packed Monolayers using Direct Assembly at the Air–Water Interface and Subsequent Plasma-Induced Size Reduction"

Image 1 and 2:

Self- Assembly of Nanospheres for Plasmonic Arrays

THE GOAL :

- Obtain Hexagonal-Closed Packed and Ordered Arrays
- Produce Plasmonic Devices to Gain Optic Response (ex : Solar cells or Biosensors)

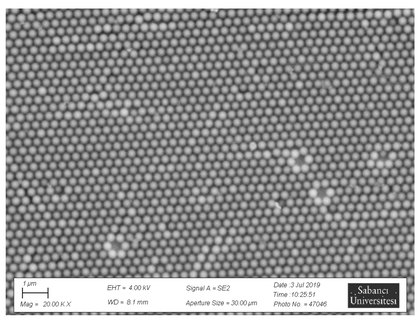
Image 3:

THE GOAL : Procure Monolayer fabrication process onto air/water interface

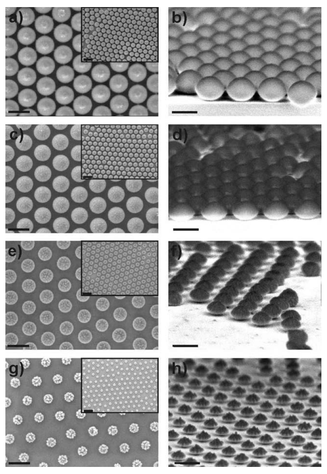
Experimental Setup :

- Organizing the experiment due to parameters like:
  - Amount of SDS (sodium dodecyl sulfate)
  - Diameters of nanospheres
  - Value of pH
  - Ratio of ethanol
- Preparation of the suspension (polystyrene) and the bath

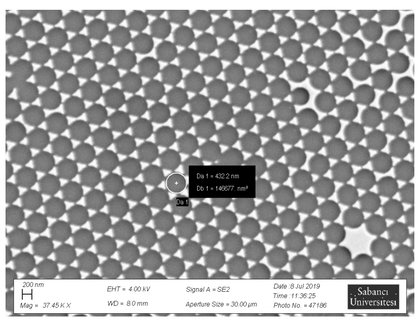
SEM (Scanning Electron Microscopy) Images



350nm – 0.2SDS – pH:10.5
Nanospheres
Self-Assemble

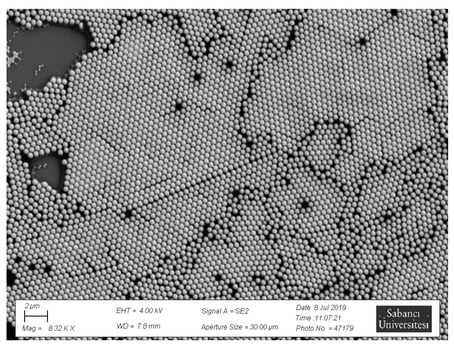


Polystyrene Monolayer Subjected to Oxygen Plasma = Etching



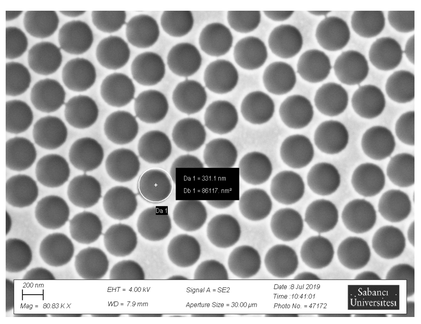
500nm – 0.1SDS – pH:10.5 - 50nmag
Nanotriangles

Removing nanospheres



500nm – 0.5SDS – pH:10.5 - 50nm Ag(silver)
Nanospheres

Depositing thin film



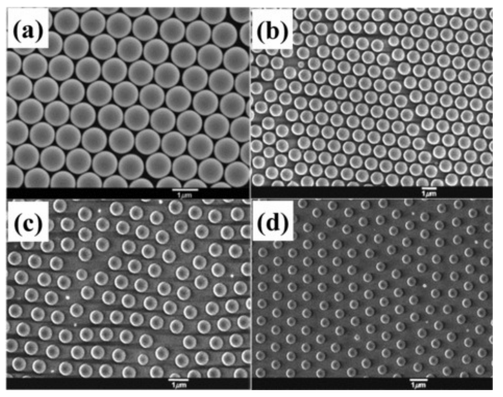
500nm – Nanoholes

CONCLUSION

THE GOAL : Obtain Different Type of Arrays by Changing the Parameters

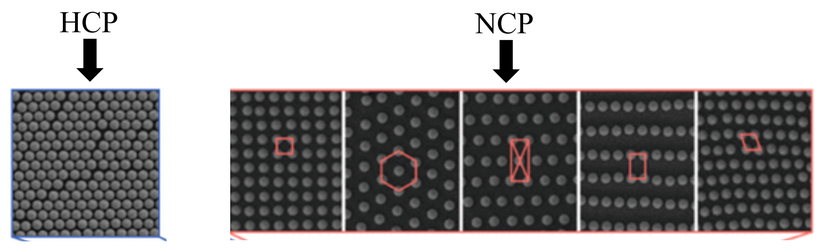
Parameters:

- Diameters of Polystyrene Nanospheres (200nm-350nm-500nm-1000nm)
- Etching Rate : Time, Power, Pressure
- Etching : Diameters of the nanospheres are sufficiently reduced while conserving their position.



"SEM images of 2D PS colloidal crystals. (a) Initial 1000 nm microspheres in closely packed arrays, (b-d) non-close-packed colloidal crystals by plasma etching 4, 6, 7 min, respectively."

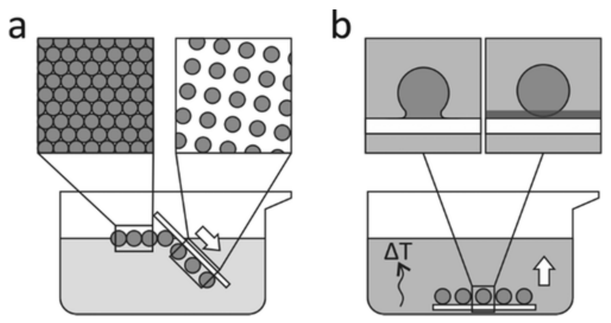
FUTURE WORK



THE GOAL :

- Fabrication the Desired Ordered Arrays (Non-Hexagonal Ordered Arrays)
- Control the Optical Properties

Method for Non-Hexagonal Closed Packed Monolayers : STRETCHING

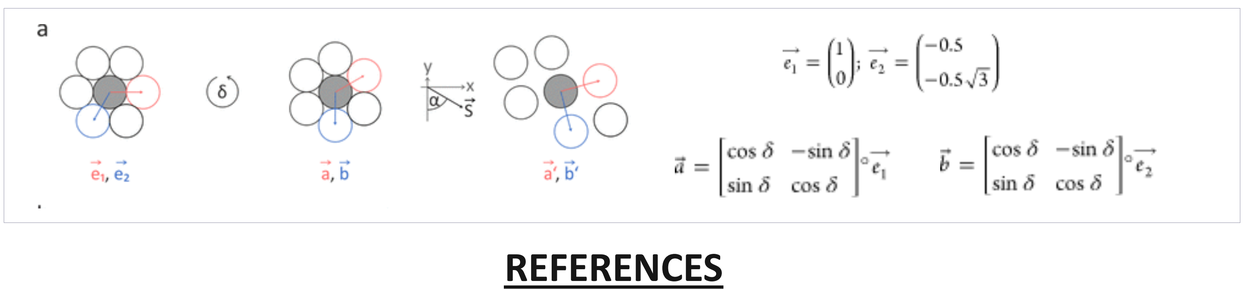


(a) Transfer of HCP monolayer from air/water interface to the lower side by submersion. The monolayer is stretched into a NCP.
(b) Immobilization of the particles on the substrate via T_g (thermal temperature of the particles or the substrate).

Experimental setups of stretching method:

- Coating the substrate with a thin polymer
- Hydrophobic substrate and contact angle
- Thermal fixation (Tg :transition temperature)
- Calculations after SEM images (rotation angle δ, base vectors $\vec{a}$, $\vec{b}$, $\vec{e_1}$,$\vec{e_2}$ and stretching vector $\vec{S}$ etc.)

Calculations:



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