



Protein Arrays As Nanomaterials

CY722 Chemistry of Novel Materials

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
Introduction

- What are Proteins
- What are protein arrays
- Why proteins arrays
- There making
- There usage

Proteins

- Proteins are basic building blocks of biological systems
- They are made Amino Acids
- These are linked together by peptide bonds which essentially are amide linkages
- Except Glycine all the other amino acids are optically active thus rendering a particular rigid structure to the protein

Protein Structure

- Protein Structure is classified into
 -  Primary Structure
 -  Secondary Structure
 -  Tertiary Structure
 -  Quaternary Structure

Protein Arrays

- Periodical Arrangement of proteins
- They are arranged in a tailored fashion to be used as desired
- Their sizes range from 100-300 nm
- They can be analyzed by Atomic Force Microscopy (AFM) or by fluorescence techniques
- They have a wide range of uses

Preparation Techniques

- Patterning Techniques
- Photolithography
- Microwave Printing
- Spot arraying
- Finely focused ion beam lithography
- Micro fabricated PAGE
- High precision contact printing on microscopic glass slides

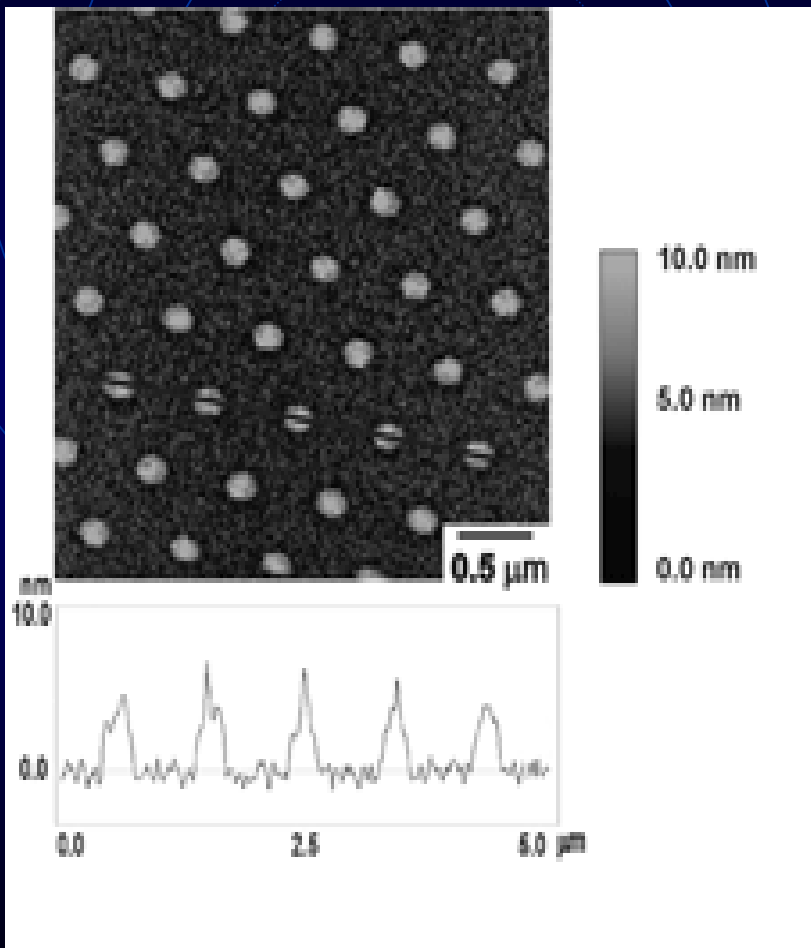
Nanolithography

- The Gold thin-film surface is patterned with 16-mercaptohexadecanoic acid (MHA) in a definite pattern.
- The other areas were passivated using ethanolic solution of 11-mercaptoundecyl-tri(ethylene glycol).
- The proteins were adsorbed on the MHA patterns by immersing the gold substrate in to solution containing the desired protein for an hour.

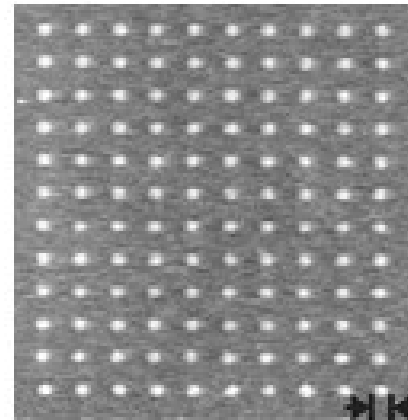
Nanolithography (Contd.)

- Here proteins with high affinity for carboxylic acid groups are used.
- They should have relatively weak affinity towards glycolic surface.
- They are characterized using AFM.
- For e.g. The arrays composed of Immunoglobulin G (IgG) patterns it is analyzed by its reaction with rabbit antibody to mixtures of proteins was studied by AFM.

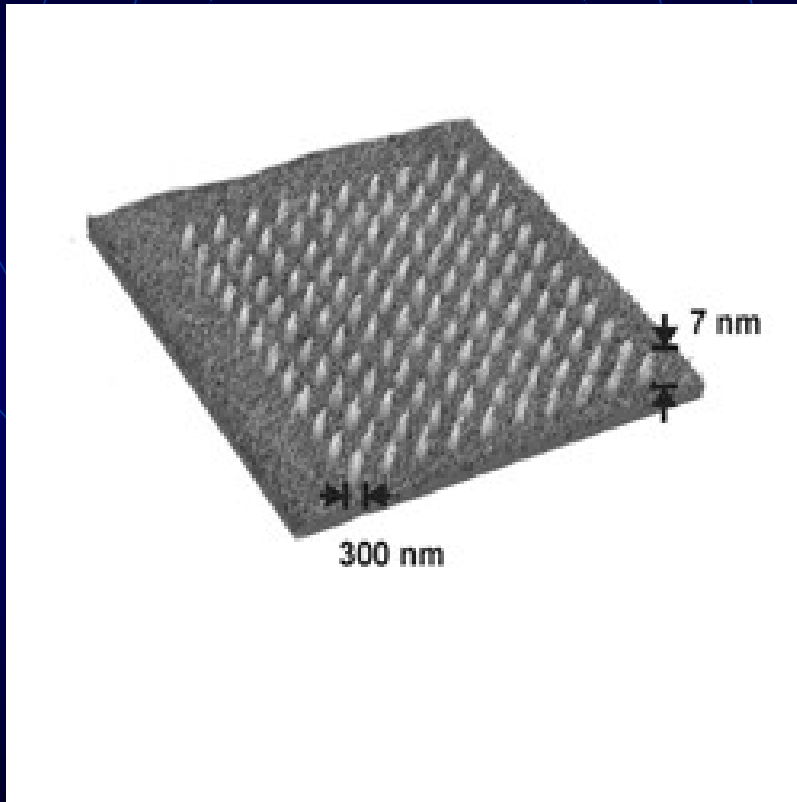
A tapping mode image and height profile of a hexagonal lysozyme nano array. The image was taken at a scan rate of 0.5 Hz to obtain high resolution



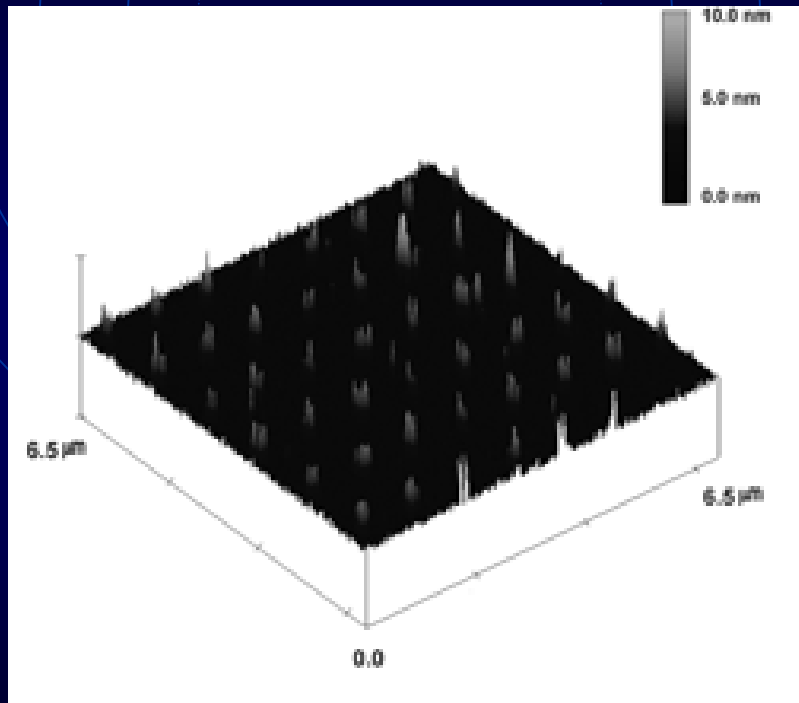
Topography image
(contact mode) of
the IgG nanoarray



300 nm



Three-dimensional
topographic image of
the same area
displayed in the
previous picture



A tapping mode three-dimensional image of rectronection nanoarray.

Micro fabricated PAGE

- Here microscopic glass slides are used
- The proteins are arrayed using micro fabricated Polyacrylamide Gel Pads.
- Subsequent electrophoresis is done.
- The slides usually used have aldehyde containing silane reagent.
- The amino termini form a schiff's base with the aldehyde groups.
- They are studied using Fluorescence techniques.

Uses of Protein Arrays

- Used for studying biological reaction.
- Used to study cell adhesion and signaling.
- Used for doing micro and nano assays.
- Used in studying expression of various genes in nano quantities.
- They can be used as Quantum Dots
- They can be used as nanoparticle probes in recognition and detection of Biomolecules

Summary

- Protein are ideal materials which can be used in monitoring biological systems
- Protein arrays are used in various application
- They can be used nano materials as there dimensions are comparable to that of nanometer.
- They are tomorrow's science

References

- Gavin MacBeath and Stuart I. Schreiber, *Science*(289), 2000, 1760-1763.
- Ki-Bum Lee, So-Jung Park, Chat A. Mirkin, Jennifer C. Smith, Milan Mrksich, *Science*(295), 2002, 1702-1705.