MODEL COURSE OUTLINE (LAB EXPERIMENTS)

FOR

M.TECH. PROGRAMME IN NANOSCIENCE & NANOTECHNOLOGY

LIST OF EXPERIMENTS

METAL AND SEMICONDUCTOR NANOPARTICLES

Chemical synthesis of Ag nanoparticles; UV-Visible absorption of the colloidal sol; Mie formalism; Estimation of size by curve fitting.

Chemical synthesis of CdS nanoparticles; Optical absorption spectra; Band gap estimation from the band edge.

Aqueous to organic phase transfer of Ag and CdS nanoparticles; Confirmation by UV-Visible absorption.

Synthesis of Au and Ag nanoparticles at aqueous-organic liquid interface; UV-visible spectroscopy of the colloidal film; comparison with the corresponding colloidal sol.

Sol gel synthesis of ZnO nanoparticles

Micellar route to Pt nanoparticles

A bioroute to Au nanoparticles

Room temperature B-H loops for γ-Fe_2O_3 nanoparticals of different sizes (5-50 nm).

C_{60}

Pristine and polymerized C_{60}; UV-visible spectroscopy

THIN FILM DEPOSITION

Operation of Electrochemical Workstation.
Deposition of Polyaniline on ITO using Electrochemical Workstation.
Electroplating Ag film: Topography by AFM; Electrical characteristics by two and four probe measurement.
Electroless deposition of Au on Si substrate.
Physical vapor deposition of Cr and Au on glass substrates; X-ray diffraction measurement; Quartz crystal thickness monitor for thickness monitoring.
Preparation of (111) oriented films of Au by physical vapor deposition on mica substrate; X-ray diffraction measurement; characterization by AFM.

FUNCTIONAL SURFACES

Contact angle measurements of liquid droplets- water and hexane droplets on glass, HOPG and mica surfaces; water droplets on hydrophilic and hydrophobic Si surfaces; water droplets on SiO_2/Si surfaces at different oxide thicknesses; water droplets of silanised glass.

SELF-ASSEMBLY

Synthesis of Pd alkanethiolates of different alkyl chain lengths. Estimation of bilayer thickness using powder X-ray diffractometer; Lattice melting and hysteresis

Self-assembled monolayers of hexadecanethiol on Au(111); topography by contact and non-contact AFM.

Stearic acid monolayer on water; π-a isotherms, transfer onto Si substrate; non-contact AFM characterization.

NANOMETROLOGY AND MICROSCOPY

Determination of size and lateral dimensions of various samples (pollen grains, strands of hair) using a high magnification optical microscope.

Synthesis of SiO_2 polysphere film and morphology characterization using a Optical microscope.

Surface topography of a sputtered Au film using AFM; thickness across a step.

Surface topography of a freshly cleaved mica using AFM; step measurements

Surface topography of a polymer film on glass using AFM in the non-contact (tapping) mode; Phase imaging

Nanoindentation on a polycarbonate substrate using AFM; F-D curves and hardness determination.

Dip-pen lithography using AFM with molecular inks.

Surface topography of a sputtered Au film using STM; current and height imaging.

Surface topography of a freshly cleaved HOPG using STM; step measurements

Scanning Tunneling Spectroscopy (STS) on Multi walled Carbon Nanotubes deposited on HOPG.

Piezoelectric drive based Nanopositioner; Michelson interferometer for displacement measurement.

Optical microscopy of graphene on oxidized Si substrate; thickness measurement by AFM

MICRO & NANOLITHOGRAPHY

Clean room: Familiarizing with essential terms, tools and practices.

Cleaning procedure for Si wafer and observation of surface before and after cleaning with AFM.

Spin coating polymer resists, Thickness measurement using AFM.

Optolithography using PMMA resist.

Nanoscale gratings by Electron beam lithography using SEM.

Nanosphere lithography using silica nanospheres.

Microcontact printing using PDMS stamp

COMPUTATION LABORATORY AND SIMULATIONS

MATLAB programme to plot the first four eigenfunctions of a one - dimensional rectangular potential well with infinite potential barrier.

Numerical solution of the Schrodinger wave equation for a rectangular potential well with infinite potential barrier using MATLAB programme.

Toy model in molecular electronics: IV characteristics of a single level molecule

To determine the lattice constant and lattice angles for atomically resolved STM image of HOPG (Highly Oriented Pyrolytic Graphite using offline Scanning Probe Imaging Processor (SPIP) Software.

To determine the surface roughness of raw and processed AFM images of glass, silicon and films made by different methods using offline SPIP software.

Simulation of I-V Characteristics for a single Junction circuit with a single quantum Dot using MOSES 1.2 Simulator.

Study of Single Electron Transistor using MOSES1.2 Simulator.

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