Surface Physics

PHYS381

2014

UNIVERSITY OF LIVERPOOL

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Contact:

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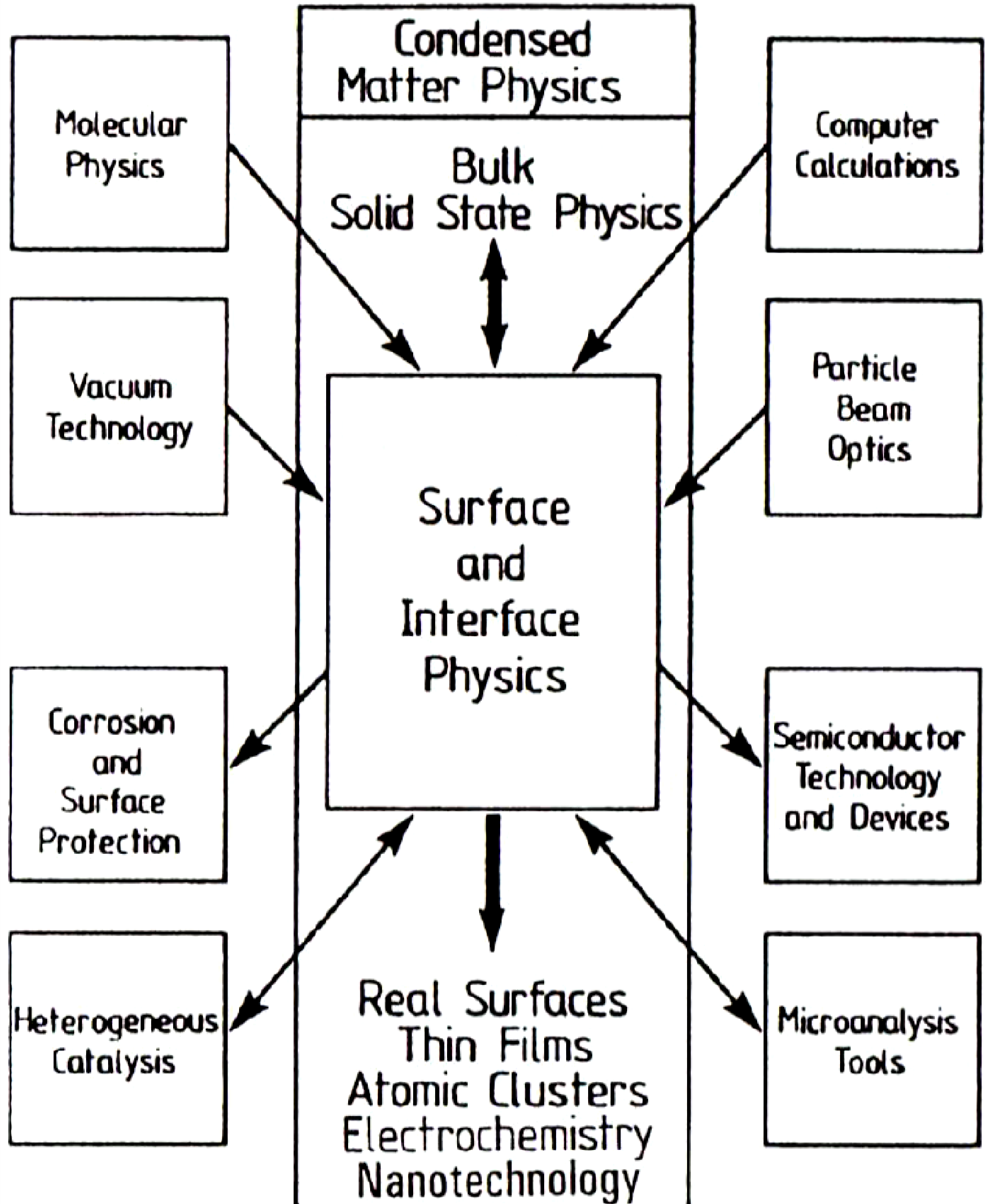

Condensed Matter Physics
Bulk Solid State Physics
Molecular Physics
Computer Calculations
Vacuum Technology
Particle Beam Optics
Surface and Interface Physics
Corrosion and Surface Protection
Semiconductor Technology and Devices
Heterogeneous Catalysis
Microanalysis Tools
Real Surfaces
Thin Films
Atomic Clusters
Electrochemistry
Nanotechnology

Lectures

Weeks 7-12

Monday 11.00 (MATH-106), Thursday 10:00 (ELEC-202), Friday 11.00 (MATH-106)

Tutorials

W7 and W10 [Hand in by noon a day before]

Credits

16 lectures, 2 tutorials, 7.5 credit

Assessment

1.5 hour written exam at the end of semester 2

50% 1 compulsory question covering broad aspects of the module

50% 1 detailed compulsory question (2 options)

Lecture notes/tutorial sets

Available via VITAL

Hard copy handout

Laboratory tour

A tour will be arranged for observation of surface science laboratory

Surface physics

- Study of the atomic arrangements and chemical composition at the surfaces and the interfaces of solids.
- Theory and observation of their mechanical, electronic and chemical properties.
- Understanding of relationships between the properties, the composition and the structure.

Objectives of this module

- To explain the physical properties of crystal surfaces.
- To convey an understanding of the techniques of surface physics.
- To convey an understanding of the extent to which surface properties can be monitored and controlled.
- To show how the properties of surfaces are of technological importance.

Content

4. Real Surfaces

- 4.1 Surface defects
- 4.2 Surface reconstruction
    - 4.2.1 Missing row structure in the fcc (110) metal surfaces
    - 4.2.2 Dimerization at the (100) surface of group IV elements
    - 4.2.3 Dimer adatom stacking fault model for Si(111)-(7x7)
- 4.3 Surface relaxation
- 4.4 Surface preparation techniques

5. Electron Diffraction

- 5.1 Low Energy Electron Diffraction (LEED)
    - 5.1.1 Working principle
    - 5.1.2 Universal curve for inelastic mean free path
    - 5.1.3 Interaction of electrons with matter
    - 5.1.4 Bragg diffraction conditions
    - 5.1.5 Ewald’s sphere
    - 5.1.6 Implementation (examples)
    - 5.1.7 Indexing of diffraction patterns
- 5.2 Kinematic theory of electron diffraction
- 5.3 Dynamic LEED (I-V LEED)
- 5.4 Spot Profile Analyzing–LEED (SPA-LEED)
- 5.5 Reflection High Energy Electron Diffraction (RHEED)

6. Scanning Probe Microscopy

- 6.1 Background knowledge
  - 6.1.1 Electronic structure of solids
    (Band structure, occupied states, unoccupied state, Fermi level, density of state)
  - 6.1.2 Quantum mechanical tunnelling
- 6.2 Scanning Tunnelling Microscopy (STM)
  - 6.2.1 Introduction, working principle
  - 6.2.2 Mode of operations
  - 6.2.3 Experimental challenges and limitation
  - 6.2.4 Applications
    (Topology, spectroscopy, atomic manipulation, spin polarized-STM)
  - 6.2.5 Limitation
- 6.3 Atomic Force Microscopy (AFM)

7. Electron Spectroscopy

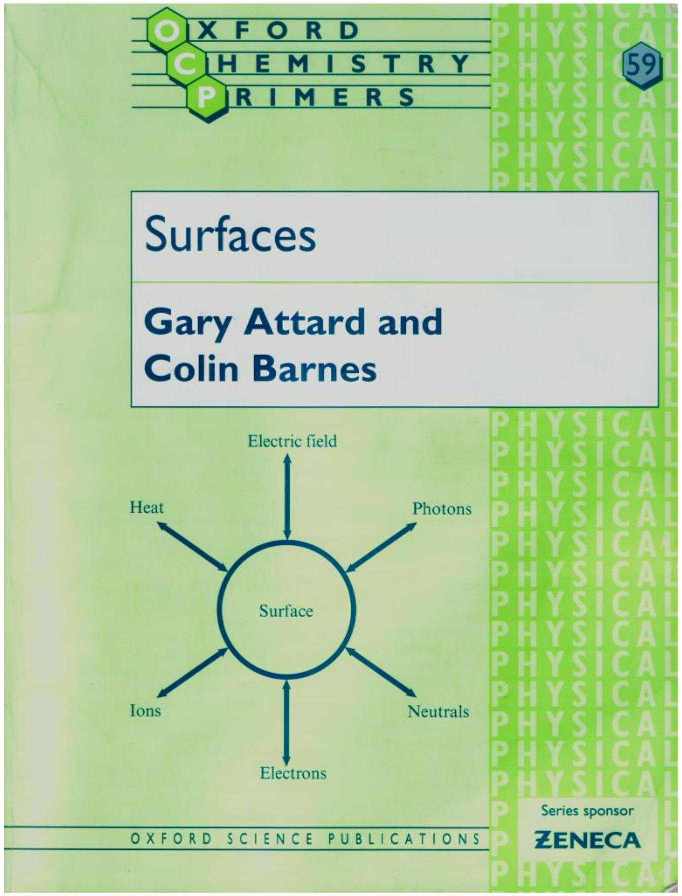
- 7.1 Principle of electron spectroscopy
- 7.2 X-ray Photoelectron Spectroscopy (XPS) or
  Electron Spectroscopy for Chemical Analysis (ESCA)
  - 7.2.1 Working principle
  - 7.3.2 X-ray sources
  - 7.3.3 Electron energy analyzers
    (Hemispherical analyzer and cylindrical mirror analyzer)
  - 7.3.4 Application
    Elemental identification, quantitative chemical analysis
    chemical shift or core level shift

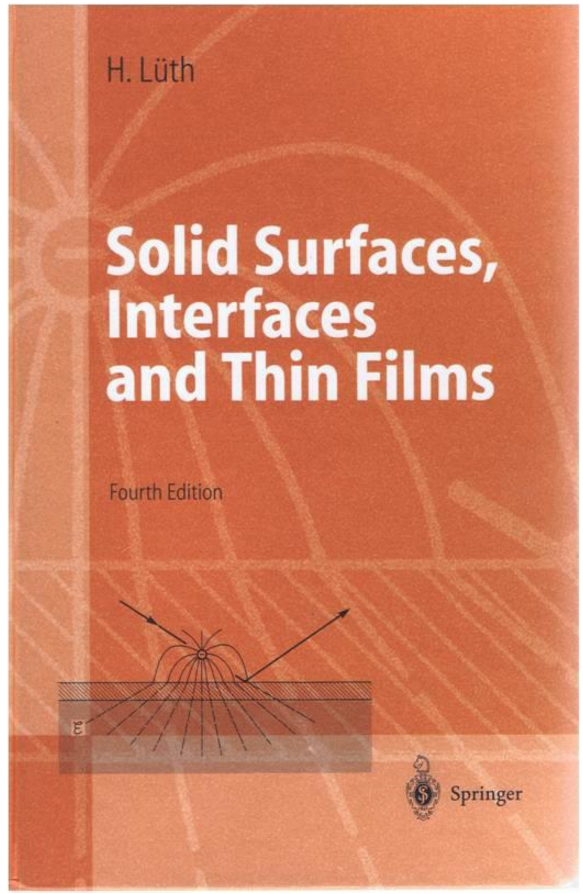
- 7.3 Auger Electron Spectroscopy (AES)
    - 7.3.1 Auger process, Auger transition notation
    - 7.3.2 Auger electron vrs photoelectron
    - 7.3.3 Auger spectrum
- 7.4 Ultraviolet Photoemission Spectroscopy (UPS)
- 7.5 Synchrotron Radiation

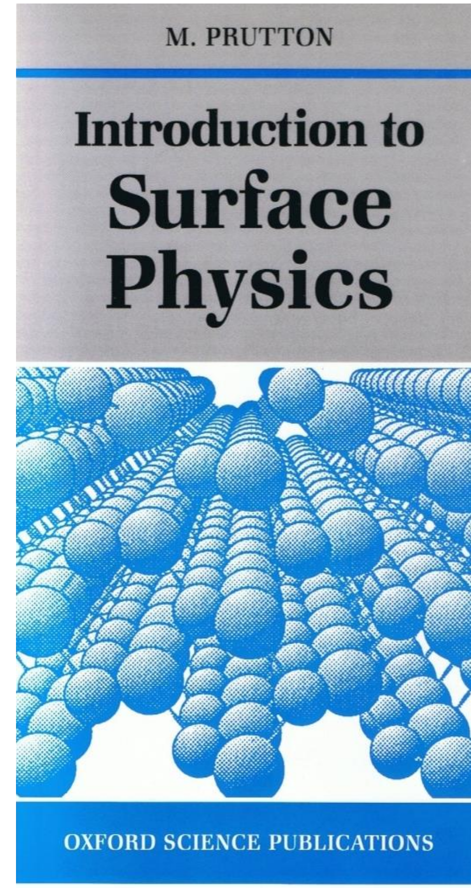
8. Thin Film Growth

- 8.1 Molecular adsorption (interaction of gases with solids)
    - 8.1.1 Adsorption and absorption
    - 8.1.2 Associative and dissociative adsorption
    - 8.1.3 Physisorption and chemisorption
- 8.2 Gas-liquid-solid interface
    - Surface tension, contact angle and adhesion
- 8.3 Thin film growth (Solid Film)
    - 8.3.1 Atomic process
    - 8.3.2 Growth modes
    - 8.3.3 Epitaxy, heteroepitaxy and homoepitaxy
- 8.4 Film growth techniques
    - 8.4.1 Molecular beam epitaxy (MBE)
    - 8.4.2 Applications of MBE
        - Multilayer structures
        - Quantum well
        - Band-Gap engineering
    - 8.4.3 Chemical vapour deposition (CVD)

Book References







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