המחלקה לכימיה
הפקולטה למדעים מדויקים
אוניברסיטת בר־אילן

Lust update: 8/3/21

Name and Course Number:

Surface Analysis- Theory and application

84-857-01

Dr. Yossef Gofer

Course type:

Year of Study: 2022 Semester: 2 Hours: 2

Course website:

Day & Time: Sunday 10:00-12:00

A. Course Objectives:

The course provides the students with theoretical and semi-practical knowledge in the four most important surface analysis methods today: XPS, AES, SIMS and RBS

B. Course Contents:

After a brief introduction to the chemistry of surfaces, the students receive a comprehensive overview of the range of analytical methods for chemical and physical-chemical analysis of surfaces and thin layers. Then I elaborate on in-depth study of the four leading methods of surface analysis: XPS, AES, SIMS and RBS. We will study the main issues pertaining to each of the individual methods in terms of the theory and the physical phenomena that underlie the method. The lectures give also an overview of the various parts of the instruments, followed by a thorough discussion of spectra interpretation using several representative examples. At the end of each section we elaborate on special uses as well as of selection and preparation of samples for analysis.

Lessons:

Detailed teaching program for all classes:

Lesson no.	Subject of lesson	Required reading	Comments
1	Introduction to chemistry and surface analysis. Review of modern qualitative methods for surface analysis		
2	A review of quantitative modern methods for surface analysis Review of modern methods for measuring physical parameters on surfaces A review of modern high quality surface imaging methods. The importance of surface analysis to the world of nanotechnology and materials science		
3	XPS: Introduction and Theory. "Ultra-High" vacuum systems The XPS spectrometer. Qualitative XPS analysis Peak shape and width. Initial and final state effects.		
4	Energy resolution in XPS Background emission XP Auger line shapes Charging effects Base-line correction Peak fitting Signal smoothing UPS XPSכמותי The Relative Sensitivity Factor Accuracy and repeatability Depth profiling Angle resolved XPS Sputtering		
5	Scanning XPS (chemical mapping) sample requirements and sample preparation UHV incompatible elements (for X-ray exposure and sputtering)		

	Some examples for XPS analysis: case studies Short visit at the XPS Lab		
6	AES theory Auger Electrons production The shape of the AES spectrum Electrons penetration depth and electron escape depth Relative probability of AES emission AES Instrumentation		
7	Qualitative AES analysis Spectral interpretation The AES emissions nomenclature Chemical shift in AES. final state effects		
8	AES line intensity Depth profiling Scanning AES: chemical mapping Sample requirements Sample preparation. AES sample damage.		
9	SIMS Theory Ion beam sputtering: The generation of secondary ions Fragmentation rules TOF-SIMS Conventional (dynamic) SIMS Chemical imaging with SIMS Secondary ions energy distribution The secondary ions: Energy distribution Secondary Ion Yields: Elemental Effects Secondary Ion Yields: Primary Beam Effects		
10	SIMS instrumentation The primary ion beam source Scanning methods The analyzer The detector Spectral analysis: Qualitative analysis Quantitative analysis Relative sensitivity factor Detection limit Databases		
11	Mass Interferences Depth profiling and depth resolution Bulk analysis		

	Sample preparation and sample requirements Which kind of samples can really be analyzed by SIMS Sample vacuum compatibility Charging effects Sample damage Vacuum and recontamination Chemical imaging: mapping Ion Beam Analysis: Theory. Ratherford Backscattering Spectroscopy: Spectra interpretation- Kinematics Scattering Cross Sections Stopping Power		
12	Spectral interpretation Layer Thickness Measurements Elemental Ratios Elemental Concentrations RBS Instrumentation Tandem Accelerators Beam Line and Tank Stripper Elements Source of Negative Helium Ions Particle optics: Focusing Elements Sample Chamber The detector Sample preparations Special effects and methods in IBA. Straggling		
13	Channeling Bragg's Rule Density Effects <u>Related techniques and phenomena</u> Inelastic backscattering scattering Elastic Recoil Detection Analysis		
14	Particle (Proton) induced X-ray Emission spectroscopy Particle Induces Gamma-Ray Emission spectroscopy Nuclear Reaction Analysis Ion implementation		

C. Course requirements:

Prerequisites: BSc in chemistry.

Debts / Requirements / Assignments: Exam

Components of the final grade (passing number / grade): Exam

D. Bibliography (recommended):

- **General surface Analysis:**
  - **Surface analysis: the principal techniques / edited by John C. Vickerman: very general and shallow. Good just for browsing**
  - **Modern techniques of surface science / D.P. Woodruff & T.A. Delchar. Good just for browsing**

- **XPS and EIS**
  - **Practical Surface Analysis: By Auger and X-Ray Photoelectron Spectroscopy AES / D. Briggs. Very thorough book. Not available in BIU**
  - **http://srdata.nist.gov/xps/ : the most thorough and reliable database for XPS**
  - **http://www.uksaf.org/home.html: good source for general data, especially the tutorials.**
  - **http://www.eaglabs.com/en-S/references/tutorial/augtheo/caiatheo.html**
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- **SIMS**
  - **Secondary Ion Mass Spectroscopy of Solid Surfaces / V. Cherepin; Very thorough book. Not available in BIU**
  - **Solid Surfaces, Interfaces and Thin Films / H. (Hans) Lüth; Very thorough book. Not available in BIU.**
  - **http://www.eaglabs.com/en-US/references/tutorial/simstheo/caistheo.html**
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- **RBS**

- http://www.eaglabs.com/en-S/references/tutorial/rbstheo/cairtheo.html

Mandatory material for tests: