Course Title (in English) | Introduction to Surface Physics
---|---
Course Title (in Russian) | Введение в физику поверхности
Lead Instructor(s) | Ionov, Andrey
Is this syllabus complete, or do you plan to edit it again before sending it to the Education Office? | The syllabus is a work in progress (draft)
Contact Person | Andrey Ionov
Contact Person's E-mail | tsir@elch.chem.msu.ru

1. Annotation

Course Description

This course assumes the study of techniques able to provide information concerning electronic and atomic surface structure. The techniques can be applied to materials and nanostructures research. The students should learn how the surface is arranged, what are the specific properties of the surface, what processes occur at the surface and interfaces, including metal-semiconductor interface and some other interfaces typical for heterostructures. Adsorption, interfacial reactions and films growth are also considered. Vacuum techniques of surface characterization are accented.

Course Prerequisites / Recommendations | General course of solid state physics, non-zero knowledge of chemistry at the undergraduate level.

2. Structure and Content
<table>
<thead>
<tr>
<th>Course Academic Level</th>
<th>Master-level course suitable for PhD students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ECTS credits</td>
<td>3</td>
</tr>
<tr>
<td>Topic</td>
<td>Summary of Topic</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
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</tbody>
</table>
| General aspects.       | 1. Introduction: the role of surface in physics and chemistry.  
3. Basics of 2D crystallography. 2D lattices. Miller indexes and presentation of the surface atomic structure. The reciprocal 2D lattice. Relaxation, reconstruction. Physical properties of the surface as determined by its atomic structure. Interfacial defects. | 5                     | 6                     |                   |
5. Methods and principles of ion spectroscopy. Secondary ion mass spectroscopy (SIMS): physical backgrounds, experimental features, and equipment. Thermodesorption spectroscopy.  
3. Assignments

<table>
<thead>
<tr>
<th>Assignment Type</th>
<th>Assignment Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>Homeworks consist of the problems formulated by instructor. For each of three topics (see the Content above) 5 problems are proposed.</td>
</tr>
</tbody>
</table>

4. Grading

<table>
<thead>
<tr>
<th>Type of Assessment</th>
<th>Graded</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Grade Structure</th>
<th>Activity Type</th>
<th>Activity weight, %</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Homework Assignments</td>
<td>70</td>
<td></td>
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</table>

Grading Scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>80</td>
</tr>
<tr>
<td>B</td>
<td>65</td>
</tr>
<tr>
<td>C</td>
<td>55</td>
</tr>
<tr>
<td>D</td>
<td>45</td>
</tr>
<tr>
<td>E</td>
<td>35</td>
</tr>
<tr>
<td>F</td>
<td>0</td>
</tr>
</tbody>
</table>

Attendance Requirements: Mandatory

5. Basic Information

Maximum Number of Students
<table>
<thead>
<tr>
<th>Maximum Number of Students</th>
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</thead>
<tbody>
<tr>
<td>Overall: 15</td>
</tr>
<tr>
<td>Per Group (for seminars and labs): 15</td>
</tr>
</tbody>
</table>

**Course Stream**  
Science, Technology and Engineering (STE)

**Course Term (in context of Academic Year)**  
Term 2

**Students of Which Programs do You Recommend to Consider this Course as an Elective?**

<table>
<thead>
<tr>
<th>Masters Programs</th>
<th>PhD Programs</th>
</tr>
</thead>
</table>
| Advanced Manufacturing and Materials  
Materials Science  
Photonics and Quantum Materials | Materials Science and Engineering  
Physics |

**Course Tags**  
Physics

### 6. Textbooks and Internet Resources

<table>
<thead>
<tr>
<th>Required Textbooks</th>
<th>ISBN-13 (or ISBN-10)</th>
</tr>
</thead>
</table>

### 7. Facilities

### 8. Learning Outcomes

#### Knowledge
- Surface crystallography.
- Surface electronic states.

#### Skill
- Choice of technique or combination of techniques to characterize a certain surface.
- Data treatment principles for various surface science techniques.
### Experience

- Analysis of original papers related to surface physics.
- Comparison of the data of various techniques applied to certain interface.

### 9. Assessment Criteria

#### Input or Upload Example(s) of Assignment 1:

**Select Assignment 1 Type**

- Homework

**Input Example(s) of Assignment 1 (preferable)**

Consider the low-index surfaces of certain crystalline material proposed by Instructor. Using X-ray diffraction data, calculate interatomic distances for non-reconstructed surfaces.

**Assessment Criteria for Assignment 1**

- Correct choice of required surfaces and quantitatively correct final values.

#### Input or Upload Example(s) of Assignment 2:

**Select Assignment 2 Type**

- Homework

**Input Example(s) of Assignment 2 (preferable)**

Consider the data of Low energy electron diffraction and X-ray photoelectron spectroscopy for certain material proposed by Instructor. Determine elemental composition and crystallographic orientation of the surface.

**Assessment Criteria for Assignment 2**

- Correct and systematic involvement of the reference data, which the student is assumed to find in the net/libraries.

#### Input or Upload Example(s) of Assignment 3:

**Input Example(s) of Assignment 3 (preferable)**

Consider the data on Gibbs adsorption proposed by Instructor. Calculate the parameter(s) of adsorption isotherm which allows the best fit for this system. Estimate the adsorption value for complete monolayer and describe possible orientation of the adsorbate molecules.

**Assessment Criteria for Assignment 3**

- Correct fitting procedure, quantitatively correct values of the parameter(s), qualitatively correct choice of adsorbate orientation in adlayer.

#### Input or Upload Example(s) of Assignment 4:

#### Input or Upload Example(s) of Assignment 5:

### 10. Additional Notes
The course will be presented in the Institute of Solid State Physics (Chernogolovka), magnetic corp, room 115. Frydays, 16.30, starting from 2.11.2018.