230692 - TECHDEV - Fabrication and Characterization Technologies for Micro and Nano Devices

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering
Academic year: 2019
Degree: MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019).
(Teaching unit Optional)
MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2013). (Teaching unit Optional)
ECTS credits: 5

Teaching languages: English

Teaching staff
Coordinator: Sandra Bermejo
Others: Joaquim Puigdollers
Isidro Martin

Prior skills
Basic knowledge of semiconductor physics and technology

Requirements
Student must have passed or being simultaneously enrolled to Micro and Nano Technologies (MNT, core subject of the Master)

Teaching methodology
Face to face classes and laboratory sessions

Learning objectives of the subject
- Ability to characterize basic semiconductor devices
- Ability to fabricate and characterize basic organic devices
- Ability to learn basic nano fabrication and characterization techniques

Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours large group:</th>
<th>26h</th>
<th>20.80%</th>
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<tr>
<td></td>
<td>Hours small group:</td>
<td>13h</td>
<td>10.40%</td>
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<td></td>
<td>Self study:</td>
<td>86h</td>
<td>68.80%</td>
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### Content

#### Basic semiconductor device characterization: the crystalline silicon diode

**Description:**
- Theory: (8 h)
  - Review of current flow through energy barriers
  - Calculation of recombination current at the space charge region.
  - Dependence of current on the temperature.
  - Impact of series and shunt resistance
  - Analysis of impedance response of c-Si diodes up to 1 MHz. Simplified model with lumped elements and complete model from EDO's solution.

**Related activities:**
- Lab: (4h)
  - 1 session: c-Si diode characterization: I-V-T. Fitting with two diode and two resistor model. Calculation of activation energy of diffusion current.
  - 1 session: impedance measurement of the diode up to 1MHz. Fitting the results and determination of characteristic diode parameters: n, Rs, lifetime, etc.

<table>
<thead>
<tr>
<th>Learning time: 44h</th>
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<tbody>
<tr>
<td>Theory classes: 8h</td>
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<tr>
<td>Laboratory classes: 4h</td>
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<tr>
<td>Self study: 32h</td>
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#### Organic semiconductor devices and technologies

**Description:**
- Theory: (8h)
  - Introduction to organic semiconductors
  - Organic devices. Flexible electronics
  - Organic Thin-Film Transistors (OTFTs)
  - Organic Solar cells (OSCs)

**Related activities:**
- Lab: (4h)
  - 1 session. Fabrication of Organic Thin-Film Transistor (OTFT) based on pentacene semiconductor.
  - 1 session. Measurement of the electrical characteristics of a OTFT: output, transfer and saturation characteristics.

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**Fabrication and characterization of nanostructured devices**

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<tr>
<td>Theory classes</td>
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<tr>
<td>Laboratory classes</td>
<td>4h</td>
</tr>
<tr>
<td>Self study</td>
<td>31h</td>
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**Description:**

Theory: (8 h)
Fabricating technology: review basic clean room fabrication techniques
Nanolithography: Optical lithography, Electron-beam lithography, Nanoimprint lithography, Multiphoton lithography, Scanning probe lithography,
Characterization: Superficial (SEM, FIB, TEM, AFM), structural (XDR, topography), energy (electrowetting, contact angle), chemical (XPS), mechanical (internal stress/residual stress, microindentation-nanoindentation, adhesion tests), optical (ellipsometry)
Case study: colloidal crystal fabrication and characterization.

**Related activities:**

Lab: (4 h)
1 session: electrospray deposition.
1 session: SEM characterization and optical characterization.

**Qualification system**

Short answer exams: 40%
Laboratory assessments: 40%
Small Project: 20%

**Bibliography**

**Basic:**