

Operando Material Characterization, 2.0 credits

Operando Material Characterization, 2.0 hp

Third-cycle education course

6FITN70

Department of Science and Technology

Valid from: Second half-year 2025

Approved by
The Board of PhD Studies

Approved
2025-06-09

Registration number

Entry requirements

Admitted to studies at postgraduate level.

Specific information

Many (organic) materials change their properties drastically under device-relevant conditions. Characterization of these properties is crucial to understanding structure-property relations, which is essential for developing novel devices or to push the state-of-the-art to higher performance. It is not straightforward, however, to characterize functional materials in these environments (*in-situ*). Even more difficult is material characterization during device operation, which frequently includes external actors working on the material (*operando*).

This course teaches the basic working principles of a variety of (*operando*) characterization techniques, including their benefits and drawbacks, of which several are available at the Laboratory of Organic Electronics (LOE) and/or IFM. This range of techniques will be treated in a series of lectures, discussing one category of techniques per lecture. By the end of this course, students will have a broad understanding of characterization techniques and will be able to design *operando* characterization experiments with relevance for organic electronics.

Learning outcomes

This course will teach a diverse group of students about the importance and practical application of *operando* characterization in general material science, and organic electronics specifically. At the end of this course, the students should:

- Have a basic understanding of the working principle and application of various characterization techniques (at LOE). See also Course Topics.
- Be able to describe the benefits, drawbacks, and prerequisites for a range of (*operando*) material characterization techniques.
- Be able to design *operando* characterization experiments, supported in-part by practical experience.
- Be able to apply the knowledge listed above to design appropriate experiments for novel materials.

Contents

Introduction to *operando* characterization and learning several (*operando*) characterization techniques:

- Gravimetry
- Ultraviolet-visible-near infrared absorption spectroscopy
- Ultraviolet-visible-near infrared emission spectroscopy
- Vibrational and low-energy spectroscopy
- Spin spectroscopy
- Photoelectron spectroscopy
- Scattering techniques
- Mechanical characterization and microscopy

Educational methods

This PhD course will be taught in person at the Norrköping campus. Upon reasonable request, the lectures can be broadcasted online. The course consists of 8 lectures, a practical day, a discussion/recap lecture and a final written examination. Each lecture will be 2 hours, and the practical day will be approximately 6 hours.

The 8 lectures will be given on a weekly basis over the course of 8 weeks, and the lectures will be finalized with a practicum and discussion/recap lecture (week 9 and 10 respectively). The week after the discussion/recap lecture there will be a written examination (week 11).

Examination

Written examination.

Grading

Two-grade scale

Course literature

Lecture notes and relevant literature will be provided during the course.

General information

Lectures: 18 h

Practicum: 6 h

Recommended study and examination: 34 h