MSE-478 **Organic semiconductors**

Nüesch Frank

Cursus	Sem.	Type
Materials Science and Engineering	MA2, MA4	Opt.
Photonics		Opt.

Language of teaching	English
Credits	3
Session	Summer
Semester	Spring
Exam	Oral
Workload	90h
Weeks	14
Hours	**3 weekly**
Courses	2 weekly
Exercises	1 weekly
Number of positions	

Summary

Organic semiconductors emerge as key materials for the digitization of our society. Students will learn about the working principles of thin organic film devices and understand the relationship between chemical structure, molecular packing and the resulting electronic and optical properties.

Content

1. Conjugated small molecules and polymers. Molecular orbitals and their role in determining electronic and optical properties of organic semiconductors
2. Short and long range interactions in organic semiconductors; van der Waals bonding, excitons and charge carriers. Photochemical reactions
3. Device applications in electronics and optoelectronics; LCD displays, solar cells, photodiodes, light-emitting diodes, transistors
4. Future directions; hybrid organic-inorganic semiconductors

Keywords

Organic conjugated molecules, conjugated polymers, molecular orbitals, absorption, fluorescence, phosphorescence, electron transport, energy transfer, solar cells, light-emitting diodes, light-emitting electrochemical cells, transistors.

Learning Prerequisites

Required courses

Basic courses in chemistry, physics or materials science

Recommended courses

Semiconductor devices. Molecular quantum mechanics. Photochemistry

Important concepts to start the course

Basic notions in thin film electronic and optoelectronic devices

Learning Outcomes

By the end of the course, the student must be able to:

- Elaborate a topic in the field of organic optoelectronic devices
- Interpret organic thin film device performance in terms of fundamental processes
- Solve a problem in the field of organic semiconductors and devices quantitatively

- Estimate the order of magnitude of physical effects occuring in organic semiconductors
- Differentiate between organic and inorganic semiconductors
- Analyze fundamental processes in organic semiconductors
- Model molecular orbitals and understand how they impact thin film device properties
- Report on a scientific publication

Transversal skills

- Demonstrate the capacity for critical thinking
- Make an oral presentation.

Teaching methods

Ex-cathedra black board/Power Point lectures
Lecture notes are available in pdf format
Exercises solved and discussed in class
Study of one scientific paper

Expected student activities

Participate actively during the lectures
Exercise work during class
Presentation of problem solutions

Assessment methods

oral exam

Resources

Bibliography

- A. Köhler and H. Bässler *Electronic Processes in Organic Semiconductors,* Wiley-VCH, Weinheim, 2015.
- Gilbert, J. Baggott, *Essentials of Molecular Photochemistry*, Blackwell Sci. Publ., Oxford, 1991.
- P. W. Atkins, *Physical Chemistry,* 11th edition, Oxford University Press, Oxford, 2018.
- P. W. Atkins, R. S. Friedmann, *Molecular Quantum Mechanics*, Oxford University Press, Oxford, 1997.
- M. Pope, Ch. E. Swenberg, *Electronic Processes in Organic Crystals and Polymers*, Oxford University Press, Oxford, 1999.
- J. Simon, J. J. André, *Molecular Semiconductors*, Springer-Verlag, Berlin, 1985.
- C. Brabec, V. Dyakonov, U. Scherf (Eds.), *Organic Photovoltaics - Materials, Device Physics and Manufacturing Technologies*, Wiley-VCH, Weinheim, 2008.
- W. Clemens, W. Fix, J. Ficker, A. Knobloch, A. Ullmann, *From polymer transistors toward printed electronics*, *J. Materials Research*, Volume 19, Number 7, pp. 1963 - 1973, 2004.
- *Handbook of luminescence, display materials and devices*, ed. By Hari Singh Nalwa, Vol 1, California-American Scientific Publishers, Stevenson Ranch, 2003.
- Müllen, Klaus / Scherf, Ullrich (Eds.) *Organic Light Emitting Devices-Synthesis, Properties and Applications,* Wiley-VCH, Weinheim, 2005.

Ressources en bibliothèque

- From polymer transistors toward printed electronics, J. Materials Research, Volume 19, Number 7, pp. 1963 â## 1973, 2004

- Molecular Semiconductors / Simon
- Handbook of luminescence, display materials and devices / Nalwa
- Molecular Quantum Mechanics / Atkins
- Essentials of Molecular Photochemistry / Gilbert
- Organic Light Emitting Devices-Synthesis, Properties and Applications / Müllen
- Electronic Processes in Organic Crystals and Polymers / Pope
- Electronic Processes in Organic Semiconductors / Köhler
- Physical Chemistry / Atkins
- Organic Photovoltaics - Materials, Device Physics and Manufacturing Technologies / Brabec

Notes/Handbook

Lecture notes are provided in pdf format