UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Organic Strategies for Materials Synthesis

2627-1-FSM02Q030-FSM02Q03001

Aims

Objectives

Organic conjugated materials are a relevant part of modern materials science. Aim of the course is to provide a detailed knowledge of the most common synthetic methods for the preparation of conjugated materials with electronic and optoelectronic application. Particular emphasis will be given to green chemistry compliant approaches

Knowledge and understanding

At the end of the course the student:

1. Understands the concept of conjugation in organic materials and correlates the extension of conjugation with optical, electrical and optoelectronical properties
2. Understands the features of the most common approaches for functionalization, arylation and olefination applied int he synthesis of organic materials
3. Can select the most appropriate synthetic approaches depending on the characteristics of the final material.

Applying Knowledge and understanding:

The student:

1. Knows the features of organic conjugated materials and understands the basic structure relationships that are relevant to devise suitable synthesis and functionalization strategies.
2. Knows the most relevant arylation strategies

3. Knows the most relevant olefination approaches.

4. Knows the state of the art approaches for the synthesis of conjugated polymers

Making judgments.

Given the structure of a conjugated molecule or polymer, the student is capable of devising a suitable synthetic approach for its preparation. Given a certain function that an organic molecule is required to perform, the student can propose functionalization strategies of molecules to optimize a certain feature.

Communication skills.

The student is trained in the reading, understanding and summarizing of scientific literature. Particular emphasis is given to the synthetic approaches and to the comparative evaluation of sustainability of various available approaches. The student possesses the specific terminology of the field, thus being in the position of discussing with counterparts possessing both a chemical and a materials science background. He possesses a “problem solving” attitude.

Learning skills.

The Student is able to extend what has been learned in classes to case studies not covered during the course. He is in particular able to autonomously manage the wide literature dedicated to the conjugated materials. He knows the research tools of the dedicated literature, including patents.

Contents

• Conjugation and aromaticity
• Features of organic conjugated materials
• Overview of synthetic methods for arylation and olefination reactions
• Metallorganic derivatives (ArLi and ArMgX) and their applications in synthesis
• Syntesis and functionalization of donor moieties
• Formylationand halogenaition reactions
• Wittig & Horner-Hammonds reactions for the synthesis of conjugated linkages
• Pd mediated reactions
• Direct arylation reactions
• Synthesis of acceptor moieties
• Polymerizations
• Characterization techniques for conjugated polymers

Detailed program

• Conjugation and aromaticity
o Hybridization of C,N,O,P, S atoms
o Double and triple bonds
o Conjugated bonds
o Homo and heteroaromaticity
o Base knowledge on heterocyclic chemistry
• Features of organic conjugated materials

o Structure of polyconjugated materials
o Transport properties
o Optical properties
o Optoelectronic properties
• Overview of synthetic methods for arylation and olefination reactions
• Metallorganic derivatis (ArLi and ArMgX) and their applications in synthesis
o Direct Litiation by deprotonation and halogen lithium exchange
o Dance of halogen and regiostability of ArM
o Grignard reagents preparation
o Use of organic metal derivatives in synthesis
• Syntesis and functionalization of donor moieties
o Halogenation and formilation (electrophilic halogenation reactions and Vilsmeier formilation, use of ArM)
• Reactions by Wittig and Horner-Hammonds for the synthesis of conjugated bridges
• Pd, Ni, Cu mediated reactions
o Stille coupling
o Suzuki coupling
o Sonogashira coupling
o Heck coupling
o Buchwald-Hartwig coupling
o Kumada coupling
o Ullman coupling
• Direct arylation reactions
• Synthesis of acceptors
o Condensation of Knovenagel
o Synthesis of polymethine dyes
o Examples of synthesis and functionalization of heterocyclic acceptors
• Polymerizations
• Characterization techniques for conjugated polymers

Prerequisites

Chemistry of materials requires an interdisciplinary approach exploiting general and inorganic, organic, macromolecular and physical chemistry (thermodynamics and chemical equilibria).

An interdisciplinary foundation is thus required, including:

- `General and Inorganic Chemistry.`
- `Organic Chemistry.`
- `Physical Chemistry (Thermodynamics and Chemical Equilibria)`

Teaching form

The course is organized with in person lessons. Lectures will be also videotaped and made available on the e-

learning platform at the end of the course to support individual study.
Teaching language will be English.

Teaching strategy:

12 two-hour lectures, in person, Delivered Didactics

Textbook and teaching resource

•Books:

Synthetic Methods in Organic Electronic and Photonic Materials: A Practical Guide
Authors: Timothy Parker; Seth Marder
DOI: https://doi.org/10.1039/9781839168833
Paperback ISBN: 978-1-84973-986-3
EPUB ISBN: 978-1-78801-814-2
PDF ISBN: 978-1-83916-883-3
Special Collection: RSC eTextbook Collection
Publication date: 04 Aug 2015

The book in available in electronic e-book format on the library site at the following address:

https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=3579778&site=ehost-live&scope=site&ebv=EK&ppid=Page-__-1

Palladium reagents and catalysts.Author(s):Jiro Tsuji
First published:23 April 2004
Print ISBN:9780470850329 |Online ISBN:9780470021200 |DOI:10.1002/0470021209

•Annotated slides

Semester

first semester.

Assessment method

Please refer to the general course syllabus (Strategies for Materials Synthesis) here for all the details regarding assessment methods and exams (including partial exams).

Office hours

On appointment by email with the professor of single modules:

Organic: mauro.sassi@unimib.it
Macromolecular: silvia.bracco@unimib.it
Inorganic: barbara.dicredico@unimib.it

Joint appointments can also be scheduled upon request for issue related to the whole course.

Sustainable Development Goals

AFFORDABLE AND CLEAN ENERGY