UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Organic Strategies for Materials Synthesis

2324-1-FSM01Q030-FSM01Q032M

Aims

objectives

Organic and hybrid 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 and of thin organic films on top surfaces relevant for 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 arylation and olefination of organic materials

3) Can select the most appropriate synthetic approaches depending on the characteristics of the final material.

4) Can device strategies for the functionalization of surfaces with thin films of organic materials, conjugated and not.

5) Can evaluate quantitatively the sustainability of a synthetic procedure and suggest strategies to improve on it

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 reactivity of selected metal and oxide surfaces of interest for the chemical deposition of thin films of organic materials.

5) Knows relevant metrics of green chemistry and uses them to critically evaluate the sustainability of synthetic procedures

6) 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. The student is also capable of proposing strategies for the functionalization of surfaces with thin layers of organic molecules.

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
• Pd mediated reactions
• Ni mediated reaction
• Oxidative couplings
• Direct arylation reactions
• Polymerizations
• Self assembled mono and multilayers
• Characterization techniques
• Green chemistry metrics
• Micellar chemistry
• On water, solventless and mechanochemical reactions

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 antiaromaticity
• 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
• Pd, Ni, Cu mediated reactions
o Stille coupling
o Suzuki coupling
o Sonogashira coupling
o Heck coupling
o Neghishi cupling
o Buchwald-Hartwig coupling
o Kumada coupling
o Ullman coupling
• Oxidative couplings
• Direct arylation reactions
o Pd mediated
o Photredox direct arylation
• Polymerizations
• Self assembled mono and multilayers
o Silicon halides reactions
o Thiols reactions
• Characterization techniques
• Green chemistry metrics
• Micellar chemistry
• On water, solventless and mechanochemical reactions

Prerequisites

Organic materials require an interdisciplinary approach. Elements of

• Materials science
•Organic chemistry
•Inorganic chemistry

are required

Teaching form

The course is organized into classroom activities, and guided reading activities. All in-class lectures will be

videotaped and made available immediately after class.

Textbook and teaching resource

- 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

•Registration of classes

Semester

first semester.

Assessment method

• Oral examination

during the exam the student will have to answer 3 general questions on the topics discussed in the lessons. The questions will focus on the ability to rearrange the concepts discussed in the lessons. Students will be encouraged to think about the possible use of their notions in practical examples/applications

Office hours

on appoitment

Sustainable Development Goals

AFFORDABLE AND CLEAN ENERGY