Materials and multimaterials for the field of energy

ECTS	Course (h)
3	18

Mention du master transmettant la fiche UE :	**Chimie et Sciences des Matériaux**
Composante de gestion de l'UE :	**Faculté des Sciences – Département de Chimie**
Responsable de l'UE :	**Eric DROCKENMULLER**
Statut du responsable :	**PR**

REQUIREMENTS

General background on the structure and physical properties of organic and inorganic materials (*e.g.* polymers, composites, metals, alloys, ceramics, semiconductors, monocrystals and thin films…).

PROGRAM

The aim is to present the main classes of materials involved in several major energy sectors and to show how the smart combination of materials allows improving the performances of components, devices and systems in the fields of energy production, conversion, storage and dissipation. Several illustrative sectors will be analyzed in terms of choice, structure and processing of the main materials involved, their associated specifications, recent and future trends, as well as economical, ecological and strategical implications.

The program will involve four different sections:

1 - A general introduction on Energy Conversion sequences and steps, the related mechanisms, the key devices, and the main materials involved.

2 - A general introduction to the upcoming energy transition and the challenges involved in the different technologies enabling the transition from fossil to renewable resources and the increasing role of electric energy for storage and distribution.

2 - A particular focus will be made on the field of electrochemical storage, the historical development in the field of batteries (previous, current, and future technologies), as well as the increasing contribution of polymer materials in this field.

3 - The specific roles of magnetic materials will be detailed. The link between chemical content and magnetic properties of materials will be explained, and the main categories of useful magnetic materials will be presented, together with the associated key physical concepts and parameters. The evolution trends over the last decades, following the frequency increase and the pervasion of power electronics, will be emphasized.

4 - The general functions of semiconductors in the field of energy will be displayed, and further detailed for three specific key areas: photovoltaic conversion, electroluminescent lighting (LED's and Laser Diodes), and electric energy conversion, for the matching of voltage and frequency between the provider and the user. A focus will be made on the ongoing evolution trend towards wide bandgap semiconductors (mainly SiC and GaN) for electric energy conversion.

SPECIFIC SKILLS

- Know the main forms of energy
- Know the main concepts, measures and units associated to energy
- Know the main functionalities involved in the control of energy: conversion, delivery, storage and loss minimization
- Know the main classes of materials involved in the energy sector and their properties (e.g. mechanical, electrical, electrochemical, thermal, optical, magnetic properties)

- Acquire basic knowledge on structure/properties correlations and processing of the main classes of materials involved in the field of energy
- Identify specifications, required properties, choice criteria of materials involved in the field of energy
- Acquire a critical thinking of the current energy paradigm
- Understand the upcoming energy transition and the complex relationship between fossil resources, greenhouse gases, as well as the production and storage of alternative energies from renewable resources
- Understand the principle of electrochemical storage as well as the key developments and limitations of current battery technologies
- Understand the roles of polymer materials and the main related evolution trends
- Understand the roles of magnetic materials and the main related evolution trends
- Understand the roles of semiconductor materials and the main related evolution trends