


 Faculty of Applied Sciences

**MAPR2473 METALLURGICAL PHYSICO-CHEMISTRY**

[30h+60h exercises] 7 credits

This course is taught in the 2nd semester

**Teacher(s):** Francis Delannay (coord.), Pascal Jacques  
**Language:** French  
**Level:** Second cycle

### Aims

Analysis of concepts of Physical-Chemistry and Thermodynamics allowing the description of phase transformations, and particularly of solid-state transformations, occurring during the processing and life cycles of industrial metallic materials.

### Main themes

Nil

### Content and teaching methods

#### Content

- Introduction : the main metallic alloys for engineering applications;
- Metallurgical Thermodynamics : thermodynamic functions and state properties : Ellingham diagrams, thermodynamics properties of solutions : Raoul & Henry laws, regular and non-regular solutions ; activity;
- Phase Diagrams : phase rule; 1-constituant system; typical binary phase diagrams of metallic alloys; introduction to ternary phase diagrams;
- Solid state diffusion : interstitial and self-diffusion; diffusion kinetics; diffusion in substitutional alloys ; diffusion short-cuts; general thermodynamic description.
- Interface thermodynamic : Gibbs model; Laplace equation; measurement of surface and interface energy; relationship between surface energy and melting heat; solid-gas surface and solid-solid interface; orientation angles and coherency; grain growth and precipitation in polycrystals and alloys;
- Solidification : nucleation; segregation; zone refinement; dendritic and cellular growths; continuous casting; structure of welded zones;
- Solid-state transformations : nucleation and growth; isothermal transformation diagrams; recrystallisation; spinodal decomposition; martensitic transformation; applications to steels and aluminium alloys;
- Electrochemistry : electrochemistry of aqueous solutions; electrolytic extraction and refinement; application to aluminium and zinc;
- Corrosion : modes of corrosion; galvanic corrosion and passivity; polarisation phenomenon; thermodynamic analysis of the corrosion : Pourbaix diagrams.

#### METHOD

One part of the course consists in lectures in relationship with exercises.

The MATR students has also to work in small groups on given topics related to the general framework of the "sustainable development". That means generally the analysis of a given metallic system under several aspects : processing, properties, environment and recycling. This work is presented during seminars for the other students.

Visits of industrial sites are also organised.

**Other information (prerequisite, evaluation (assessment methods), course materials recommended readings, ...)**

Nil

**Other credits in programs**

<b>MATR21</b>	Première année du programme conduisant au grade d'ingénieur (7 credits) civil en science des matériaux	Mandatory
<b>MECA22</b>	Deuxième année du programme conduisant au grade d'ingénieur civil mécanicien (7 credits)	
<b>MECA23</b>	Troisième année du programme conduisant au grade d'ingénieur civil mécanicien (7 credits)	