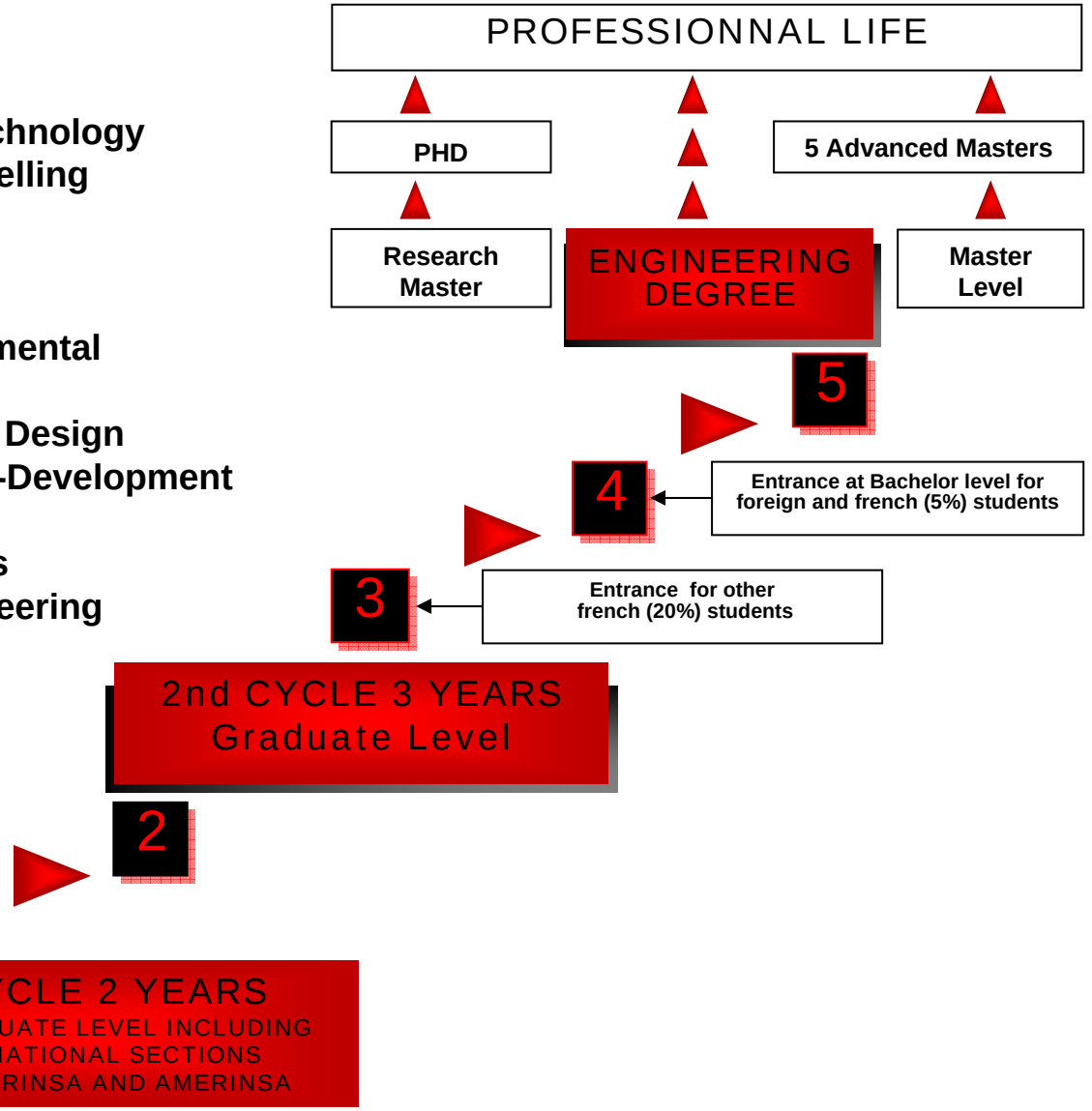
National Institute of Applied Sciences of Lyon
FRANCE

Octobre 2005

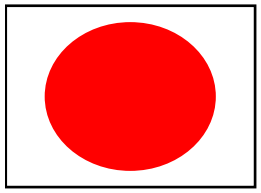
A 5-year programme

12 Specialized engineering fields

- **Biochemistry and Biotechnology**
- **Bioinformatics and modelling**
- **Civil Engineering and Urban Development**
- **Electrical Engineering**
- **Energetics and Environmental Engineering**
- **Mechanical Engineering Design**
- **Mechanical Engineering-Development**
- **Mechanical Engineering and Plasturgy Processes**
- **Materials Science Engineering**
- **Industrial Engineering**
- **Computer Science**
- **Telecommunication**



The Research at INSA of Lyon Today in some figures



- **27 Research laboratories of which:**
  - **11 Inter institutions (ECL, UCB Lyon 1, Lyon2)**
  - **17 Contractualised with EPST**
    - **15 CNRS (7 SPI, 3 STIC, 2 SC, 1 SHS, 1 SPM, 1 SDV)**
    - **1 INSERM**
    - **1 INRA**
  - **575 Teacher-researchers and Researchers including 338 in laboratories EPST**
  - **170 Administrative and Technical Staff**
  - **240 Students in DEA including 94 Students Engineers INSA**
  - **450 Doctorants**

- **Every year :** 120 thesis, 1 250 Internationals Publications et Communications,

A centre for research and socio-economic development

Energy and the Environment

Systems Security, Clean Working Practices, Waste Management and Purification, Thermic Energy, Urban Engineering, Management, Communication Engineering and Epistemology of Engineering Sciences

Science and Technology of Communication and Information

Electronic Components and Systems, Computer Science, Robotics, Micro and Nanotechnologies, Telecommunications, Data Processing

Mechanics

Solid Mechanics, Structural Mechanics, Tribology, Vibrations-acoustics

Materials :

Functional Materials, Structural Materials, Civil Engineering, Metals, Ceramics, Polymers

Biology and Health

Health Care Engineering, Biotechnology, Biochemistry and Pharmacology, Interaction Biology, Bimolecular Synthesis, Ethics

A dynamic international policy

- More than **180 partner universities** throughout the world
- Very high **mobility** rates for engineering students with 70% spending time abro

- **Increasing numbers** of foreign students on campus:

- 72 different nationalities present
- 21% of all students are foreign

INTERGROUPE des Ecoles ‘Centrale’

Centrale Graduate School

LILLE

LYON

NANTES

PARIS

Features of
Centrale Graduate School

- Students: 6 000 graduate students
  1 400 engineering degrees per year

- Staff: 500 full-time Academic staff
  1 950 part-time teachers/lecturers
  450 technical & administrative staff

- Budget: 96 million euros
  60% public / 40% private

- Research: 650 PhD students
  260 full-time researchers
  27 laboratories

The Centrale Graduate School education process

- Recruitment after 2 years of intensive coursework in mathematics & physics in the *Classes Préparatoires* (*CPGE*)
- Highly competitive entrance examinations
- Intensive general engineering education
  (2 year common core + 1 year elective course of advanced study)
- Corporate connections
  (board of administrators, project activities, full-time internships, research …)
- Strong interaction between teaching and research
- Accreditation by French national committee
  (Commission des Titres d'Ingénieur)

A pedagogical project for a generalist engineer

2 YEARS

Classes Préparatoires (CPGE)

2 YEARS

Core courses = 1800 contact hours

50%

- Preparation for international experience
- Social sciences/preparation for professional activity
- Projects and laboratory work

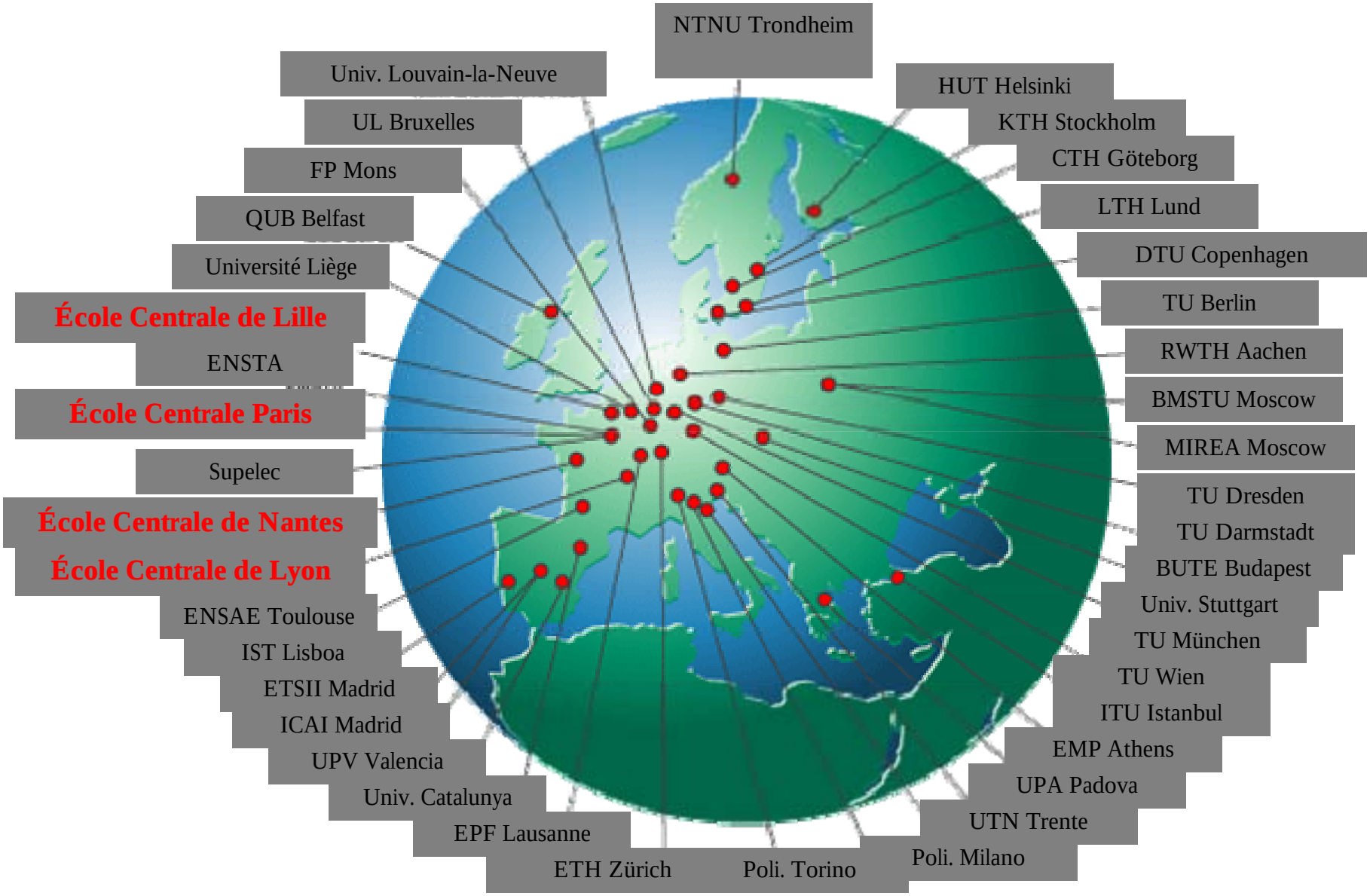
50%

- Fundamental sciences (physics, mathematics, chemistry, human sciences, economics, …)
- Technological and applied sciences (electronics, civil engineering, materials, information technology, …)

1 YEAR

Advanced study = 900 contact hours

European TIME Partners



Name and Figures

"Research Group on Physical Metallurgy and Material Physics" results from past merging of two labs

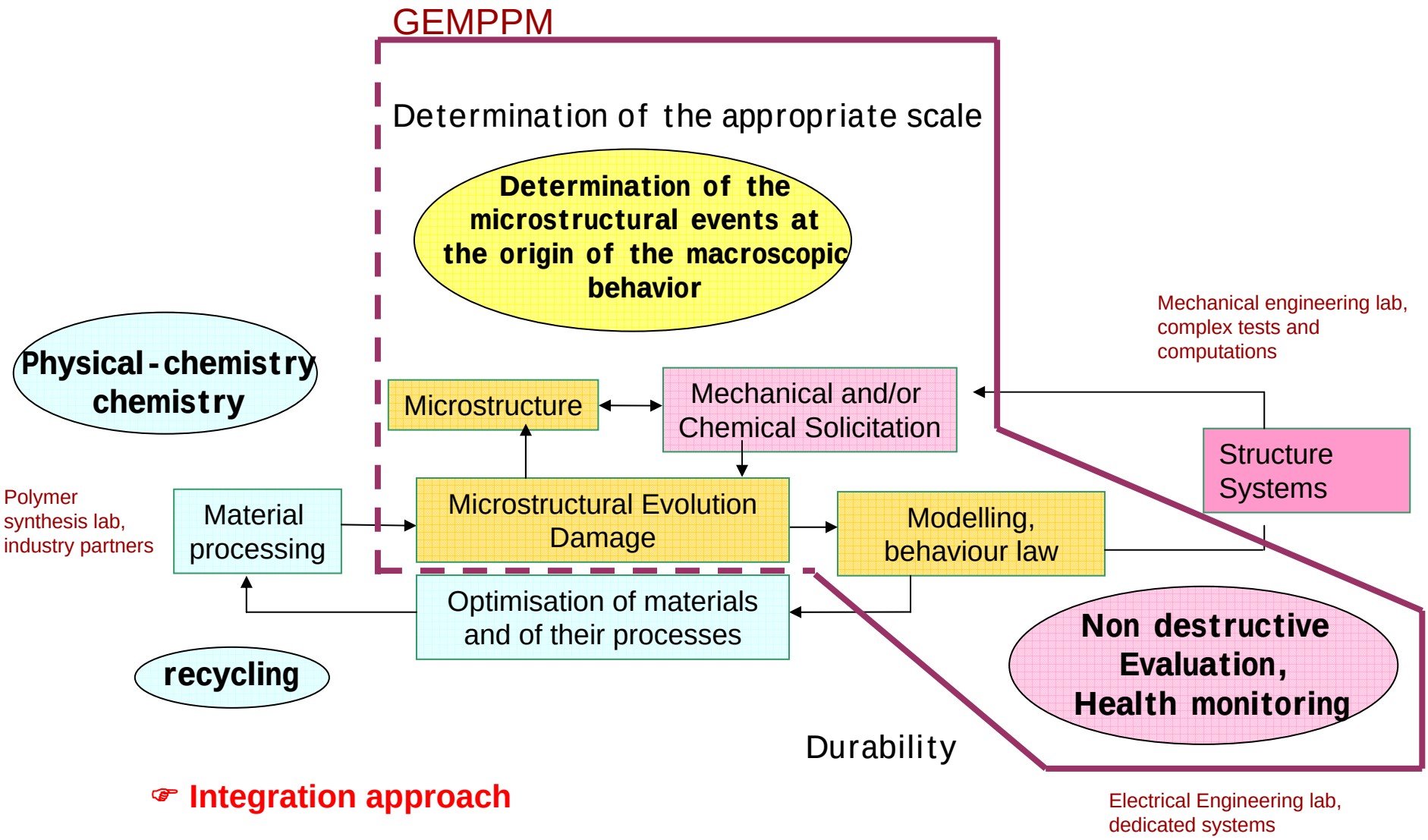
→ In fact "The Materials Science Lab" at INSA Lyon

About 140 persons including
- 48 permanent staff (26 with habilitation)
- 40 PhD students (15 PhDs per year on average)
- 20 support staff (technical or secretariat)
- Master students, foreign visitors, internships...

Evaluation by both CNRS and Ministry of Education

A majority of assoc. professors and professors in staff (with about 200 h a year teaching) ; 5 full-time researchers from CNRS

Scientific Strategy : the Material Science and Engineering retrofit chain



Trends

Nanocomposites : polymers, ceramics (specific behaviour, critical scale)
Bio-compatible and bioactive materials for prothesis, bone replacement (medical applications : elaboration, microstructure / properties)

Environmental microscopy : characterization of colloids
Development of 3D transmission electron microscopy (tomography)
Wireless health monitoring on vibrating structures

Incorporation of tomographied material architectures in FEM calculations
Modelling dynamic effects in polymer fracture
Remaining lifetime estimation of strained materials through NDE and power laws
Cohesive zone models applied to damage growth and stress corrosion

Active fund raising for future investments :
- Spark Plasma Sintering (almost completed)
- Lab-scale tomograph ('')
- shared-time SIMS ('')
- regional shared platform for environmental transmission electron microscopy, 3D characterization of microstructures by Focused Ion Beam

Established actions
New developments

Environment

INSA :

Cooperative research with other labs

- mechanical engineering –LaMCoS-
- electrical engineering –LGEF-
- polymer synthesis –LMM-
- civil engineering –URGC-

transverse task force on plastics processing

Region :

Strong involvement in

- a federation of 10 CNRS labs on structural materials (FedeRAMS)
- a cluster on Material and Structures for Sustainable Growth (45 labs)

Nation :

Industrial competitivity poles (Chemistry and Environment, Plastics processing, Mechanics for aerospace…)

International :

- > 20 countries, many European Projects
- > a European research group on Heterogeneous materials (support FedeRAMS)
- > Japan through IRCP project with Tohoku Univ.

Conclusions

Historical lab references on structural materials

* expertise in all classes of materials
* assets for microstructural and micromechanical characterization

Current extension to multifunctional materials

* biomaterials
* functional materials with structural requirements
* health monitoring

Lab policy : cross fertilization projects

* transfer of concepts from one class of materials to another
* lab seminars
* maintaining high-quality worldwide hiring of PhD students, visiting scientists, permanent staff

Two examples of Cooperative Programs

Inter-Research Centers Cooperative Program (IRCP)

Intelligent Materials System for Biomedical Application and Structure Maintenance*

- **Programme supported by the JSPS and The CNRS for 3 Years 2004, 2005 2006**
- **Bilateral programm I.FS.- INSA (with others important contributors E.CL.. Tokai Univ. …)**

*Programme initiated by Emeritus Professors Junji Tani and Pierre-François Gobin

Intelligent Materials System for Biomedical Application and Structure Maintenance

3 Topics

- **Innovation of intelligent materials and systems,**
- **Fundamental study and conceptual design of intelligent artificial muscles**
- **Fundamental study and conceptual design of multifunctional sensors for system maintenance and security.**

At the end of the second year more than 20 papers published or submitted realized in the frame of parallel or common researchs

Exchanges of Students (at different levels) and of Assistant-professors are in progress and Co-directed Thesis are expected

A lot of proposed subjects for the Office liaison are coming from this programme

Materials and Design for Sustainable development

MACODEV*

(MADESDEV)

General Scope

Main Scientific Axis

Main Tools (projects of Plateformes)

***Rhone-Alpes Cluster (Lyon,Grenoble,St Etienne ,Chambery)**

Head of the Cluster :J.Y. Cavaille

Materials and "sustainable development" ?

Answer to society's questions

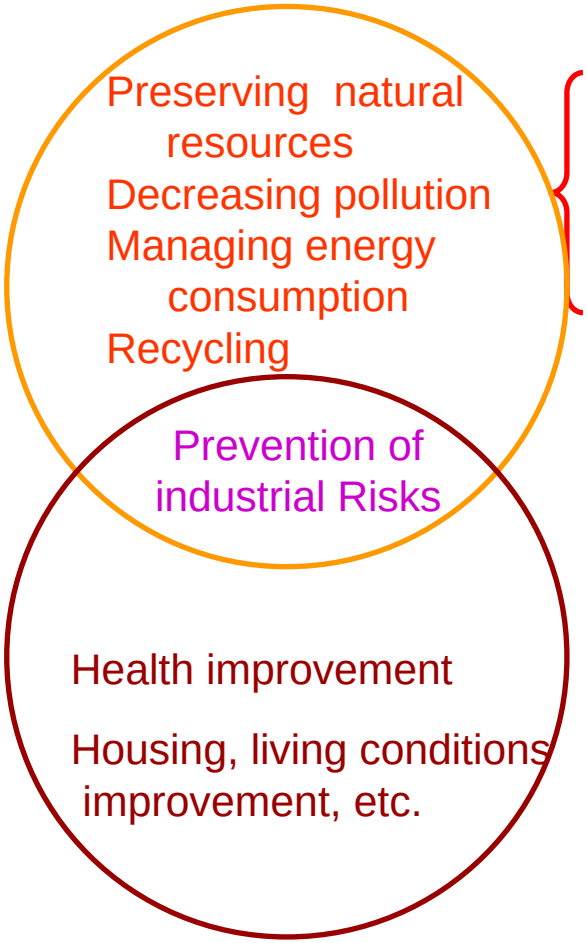
☞ **Research & development and "sustainability" ?**

Answering by new knowledge

Making breakthroughs

Proposing new concepts

Ecological concern



Quality of life

Improving process
Lighter structures (transports)
Multi-materials
Multifunctional

"Eco-conception"

Monitoring structures life time

Biocompatible materials

Multifunctional materials

New materials ?
New systems conceptions ?
New processes ?

"nano-materials" ?

Extreme Solicitations ?

Surface with specific properties
Surfaces and interfaces effects

Monitoring *in situ* Materials and structures changes
Prediction of their evolution

Integration of ≠ "know how"

Main topics ?

- **Scaling effect** : strong variations of dim, T, P, &, etc.
- **Compatibility** : role of interfaces
- **Durability** : initial lifetime, remaining lifetime

Keywords

lifetime
in situ health monitoring of materials and structures
Modeling and Prediction

New materials
New processes
New Design

"nano-materials " ?
Nano-organization (volume, surface)

Surfaces and interfaces effects
Surface with specific behavior

Biocompatible Materials

Accounting for extreme solicitations from the initial design steps

7 topics are considered

Materials and structures durability.

Elaboration, Processing – "Defectology".

Heterogeneous Systems and interface effects - Nano-organization.

Functional Surfaces.

Interaction inert substrate / living bodies (health, cellular adhesion, etc.).

Materials and structures under extreme conditions.

Conception and "Material by design".