



UNIVERSITÀ DI PISA  
DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE  
Dottorato di Ricerca in Ingegneria dell'Informazione

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Corso di Dottorato

**“Electrochemical Energy Storage. Principle and applications”**

Prof. Thierry DJENIZIAN

Professor of Materials Chemistry, Aix-Marseille University,  
Avenue Escadrille Normandie-Niemen, 13 397 Marseille France

**Short Abstract:** Nowadays, industrial and transportation activities consume a large amount of fossil fuels. The increasing energy demand accelerates depletion of stocks towards a worrying supply shortage predicted for the next century. Furthermore, emission of greenhouse gases causes a serious issue of global warming that will impact the whole society. To anticipate these concerns, sustainable energy storage using non-depleted natural resources must be seriously developed.

This course is dedicated to the principle of applications of electrochemical energy storage. It will be presented recent progress achieved in the field of Li-ion batteries and supercapacitors. The principles will be explained in terms of basic electrochemistry and thermodynamics. The relationship between properties at the atomic level with the performance of the power sources will be highlighted. Particularly, an insight into the use of nanostructured materials to improve the storage capacity, rate capability, and cyclability will be given.

**Course Contents in brief:**

I. Basics of electrochemistry

- Redox reactions
- Thermodynamics of redox reaction
- Kinetics of redox reaction (activation and diffusion processes)
- The Electrochemical interfaces (The Helmholtz Model, the Gouy-Chapmann Model, and the Stern Model)

II. Electrochemical analysis techniques for batteries and supercapacitors

- Potentiodynamic and potentiostatic experiments
- Current and potential transients
- Cyclic voltammetry
- Charge and discharge profiles
- Electrochemical impedance spectroscopy

### III. Electrochemical Supercapacitors

- Principle and applications
- Carbon- based materials for electrochemical supercapacitors
- Oxyde-based materials and the hybrid systems

### IV. Lithium-ion Batteries

- Principle and applications
- The negative electrodes for Li-ion batteries (C, oxydes, Si, ...)
- The positive electrodes for Li-ion batteries (spinel, ...)
- The different electrolytes for Li-ion batteries
- Towards the next generation of Li –based batteries (Li-air, Li-S, Li-Polymer)

**Total # of hours:** 20 (5 CFU)

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### **CV of the Teacher**

Thierry Djenizian is a Full Professor of Materials Chemistry at Aix-Marseille University. He received his Ph.D. degree in 2002 from the Swiss Federal Institute of Technology in Lausanne and the University of Erlangen-Nuremberg. His research activities are mainly focussed on the electrochemical nanostructuring of materials for applications in the field of energy storage and conversion. He is one of the Conference Chairs of Porous Semiconductors Science and Technology international conferences.

### **Room and Schedule**

Room: *Aula Riunioni del Dipartimento di Ingegneria dell'Informazione, Via G. Caruso 16, Pisa – Ground Floor*

Time: 20-24 October, 2014 9:30-13:30 am