



**Second Session of the European Ph.D. School**

**on**

**“NANOANALYSIS USING FINELY FOCUSED ION AND  
ELECTRON BEAMS”**

**BELVAUX, Luxembourg**

**March 13<sup>th</sup> – 17<sup>th</sup> 2006**

**Week1 :**

**“Secondary Ion Mass Spectrometry (SIMS),  
Transmission Electron Microscopy (TEM),  
Auger Electron Spectroscopy (AES):  
a comprehensive overview”**

## Monday, March 13<sup>th</sup>

### 8:30-9:45 **Introduction to “Nanoanalysis using finely focused ion and electron beams”**

General introduction to Static and Dynamic SIMS, TEM and AES :

- instrumentation
- ion and, or electron/matter interaction : impinging and outgoing particles
- general capabilities:
  - elemental range
  - organic/molecular information
  - crystallographic information
  - lateral resolution
  - depth resolution
  - sensitivity

**H.-N. Migeon**

### 9:55-11:10 **Ion/matter interaction I : Atomic collisions, scattering and stopping powers**

**P. Bertrand**

### 11:10-11:30 **Coffee Break**

### 11:30-12:45 **Ion/matter interaction II: Sputtering and secondary particle emission**

**P. Bertrand**

### 12:45-14:00 **Lunch**

### 14:00-18:00 **Practical sessions**

4 practical sessions will run in parallel.

Each one will last for the entire afternoon and cover instrumentation, ion/electron matter interaction and application aspects.

Practical session A: Dynamic SIMS: depth profiling (**N. Valle**)

Practical session B: Dynamic SIMS: NanoSIMS (**J.-N. Audinot**)

Practical session C: TEM (**P. Wahlbring**)

Practical session D: AES (**J. Guillot**)

These practical sessions will take place directly in front of the instruments. The attendees will be divided into 4 groups. Each group will thus attend each of the 4 practical sessions, in a rotational order, during the week.

## **Tuesday, March 14<sup>th</sup>**

- 8:30-9:45**    **Ion/matter interaction III**  
Simple emission models like bond breaking, preformed ions, cationization, protonation, deprotonation...
- A. Benninghoven**
- 9:55-11:10**    **Instrumentation : Geometrical and charged particle optics**  
- survey of main results in geometrical optics  
- introduction to charged particle optics and parallels to geometrical optics  
- overview of main optical elements found in SIMS, TEM and AES instrumentation
- T. Wirtz**
- 11:10-11:30**    **Coffee Break**
- 11:30-12:45**    **Instrumentation: Time of Flight SIMS**  
General description of ToF-SIMS instrumentation :  
- ion sources  
- primary ion columns,  
- collection optics  
- mass spectrometers  
- ion counters
- A. Benninghoven**
- 12:45-14:00**    **Lunch**
- 14:00-18:00**    **Practical sessions**

## Wednesday, March 15<sup>th</sup>

### 8:30-9:45 **Instrumentation :double focusing SIMS**

General description of DF-SIMS instrumentation :

- ion sources
- primary ion columns,
- collection optics
- mass spectrometer
- ion counters

**H.-N. Migeon**

### 9:55-11:10 **Application of SIMS : general overview of the different modes of analysis**

- sample preparation: organic, inorganic samples
- mass spectrum (resolution, interference, ...)
- ion imaging (stigmatic, scanning , resolution , sensitivity, ...)
- depth profiling
- isotopic ratio measurements
- analysis of insulators

**H.-N. Migeon**

### 11:10-11:30 **Coffee Break**

### 11:30-12:45 **Applications: Dynamic-SIMS**

- selection of bombarding conditions: brief introduction
- analytical parameters (sputtering yield, useful yield, primary ion dose, primary ion density, detection limit, ...)
- overview of dynamic SIMS applications :
  - semi-conductors
  - metallurgy
  - geo-chronology
  - biology
  - others (hard metals, composite, pollution,...)

**M. Schuhmacher**

### 12:45-14:00 **Lunch**

**Afternoon free**

## Thursday, March 16<sup>th</sup>

**8:30-9:45**

### **Interaction:electrons/matter**

- introduction to Interaction of Fast Electrons with Matter
- kinematical/Dynamical Theory of Electron Diffraction
- wave-Optical Theory of Imaging and High-Resolution TEM
- inelastic Scattering Processes and Analytical TEM Techniques

**J. Mayer**

**9:55-11:10**

### **Instrumentation: TEM**

General description of Transmission Electron Microscopy instrumentation

**J. Mayer**

**11:10-11:30**

**Coffee Break**

**11:30-12:45**

### **Applications : Static SIMS**

- important sample systems :
  - surface reactions (UHV experiments)
  - inorganic samples (metals and oxides,...)
  - molecular overlayers (on Ag, other metals, silicon)
  - polymers and additives
  - biological tissues
- main areas of applications (including examples) :
  - microelectronics
  - materials science
  - polymers
  - particles
  - life science

**A. Benninghoven**

**12:45-14:00**

**Lunch**

**14:00-18:00**

**Practical sessions**

## Friday, March 17<sup>th</sup>

**8:30-9:45**

### **Applications of TEM**

- specimen preparation including FIB
- overview on TEM-applications in materials science/nanotechnology
- introduction to biomedical applications
- electron crystallography of inorganic phases and organic molecules
- electron tomography and applications

**J. Mayer**

**9:55-11:10**

### **Instrumentation:** general description of Auger instrumentation

- e-guns
- electron analyzers

**J.-J. Pireaux**

**11:10-11:30**

### **Coffee Break**

**11:30-12:45**

### **Applications of AES**

General presentation :

- AES attributes: atomic sensitivity, quantification and detection limit (energy resolution)
- imaging capability (lateral resolution)
- depth profiling
- AES concerns:  
organic materials, charging effect, beam effects and other artifacts

**J.-J. Pireaux**

**12:45-14:00**

### **Lunch**

**14:00-18:00**

### **Practical sessions**