



Second Session of the European Ph.D. School

on

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

BELVAUX, Luxembourg

March 13th – 17th 2006

Week1 :

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

Monday, March 13th

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 14th

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 15th

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 16th

- 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 17th

- 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**