



TOF-SIMS analysis of OLEDs

Narciso Gambacorti CEA-Leti



PLATFORM FOR NANOCARACTERISATION



IRIG

Magnetic Resonance

RMN,
DNP

LETI, IRIG

Scanning Probe Microscopy

AFM, SSRM
SCM, KFM

LITEN, LETI, IRIG

Ion Beam Analysis

SIMS, TOF-SIMS,
Atomic probe Tomography

LETI, LITEN

Surface Analysis

MXPS, X-PEEM, Nano-Auger,
Use of Synchrotron facilities

eight competence centres

LETI, IRIG

Optical Analysis

Ellipsometry, FTIR, Raman, insitu
Cathodo & Photoluminescence,
Porosimetry, Spectrophotometry

LITEN, LETI, IRIG

X-Ray Analysis

μ XRD,
XRR,
Use of Synchrotron facilities

LITEN, LETI, IRIG

Sample Preparation

FIB-DB,
Polishing, Cleaving,
Chemical, Grinding

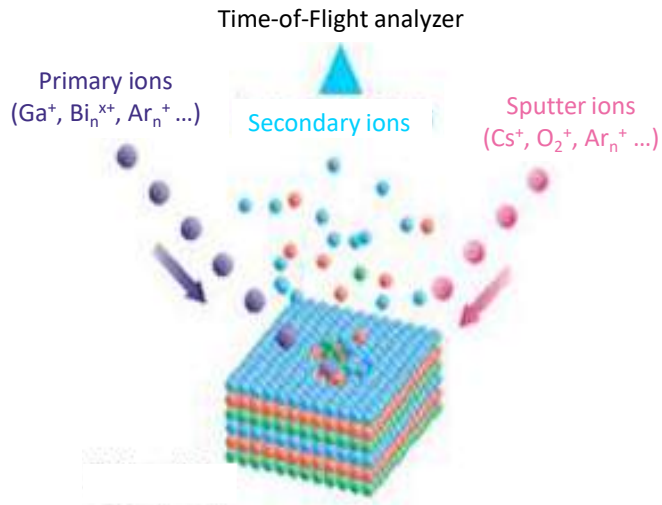
LITEN, LETI, IRIG

Electron Microscopy

SEM, EBSD, TEM, HR-(S)TEM,
Electron Holography, EDX, EELS,
P-NBED, Electron Tomography



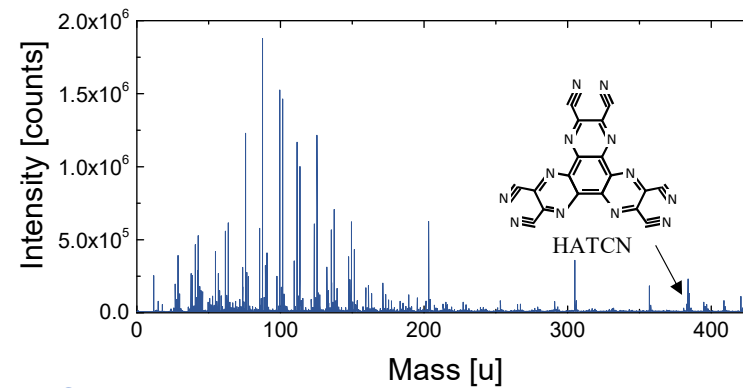
TOF-SIMS



$$t = L \sqrt{\frac{m}{2E_{kin}}} \approx 3\sqrt{m}$$

¹H⁺ (3 μs)

¹⁹⁷Au₁⁺ (42 μs)



Pros

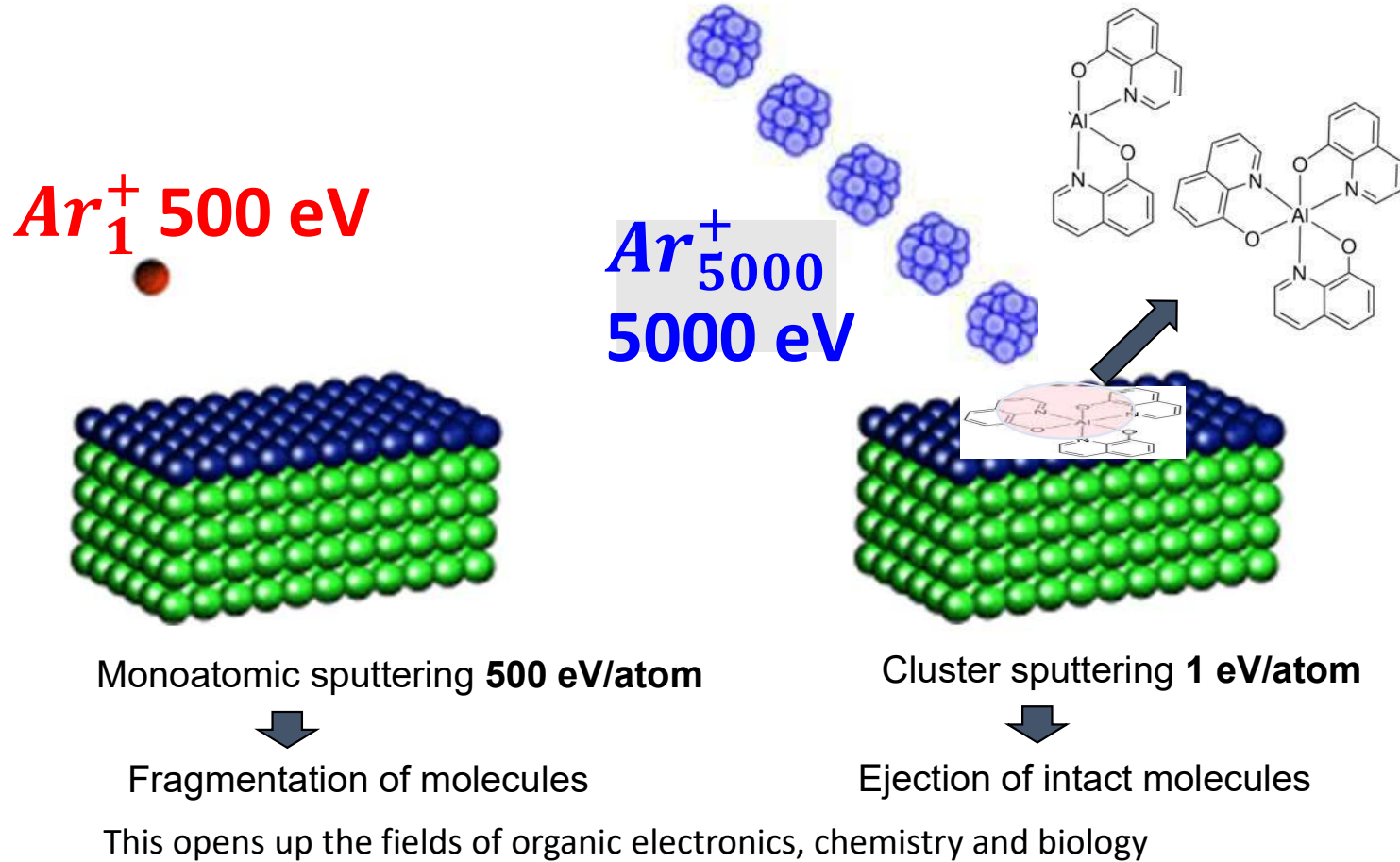
- ✓ Detection of molecules and their fragments
- ✓ All Elements and insulators analyzable
- ✓ Depth resolution (~1 nm)
- ✓ Lateral resolution (~50 nm)
- ✓ Detection limit (ppm – ppb)

Cons

- ✗ Quantification is difficult
- ✗ Destructive
- ✗ Matrix-effect
- ✗ Mass interferences

MONOATOMIC vs CLUSTER SPUTTERING

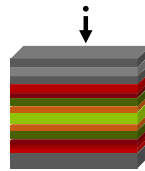
- Introduction of cluster sputtering in 2000's enables molecular depth profiling



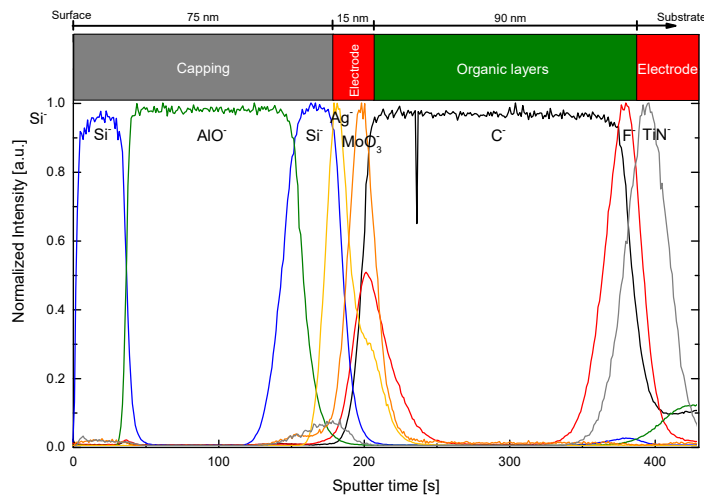
ORGANIC LIGHT EMITTING DIODES (OLEDs)

1

Monoatomic sputtering



Sputtering Beam: **1 keV Cs⁺** (50 nA, 500 x 500 μm)
 Analyzing Beam: **15 keV Bi₃⁺** (~ 0.5 pA, 300 x 300 μm)

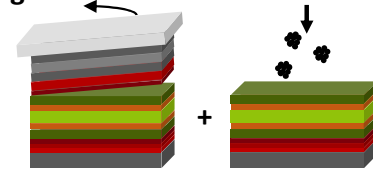


Information on inorganic layers

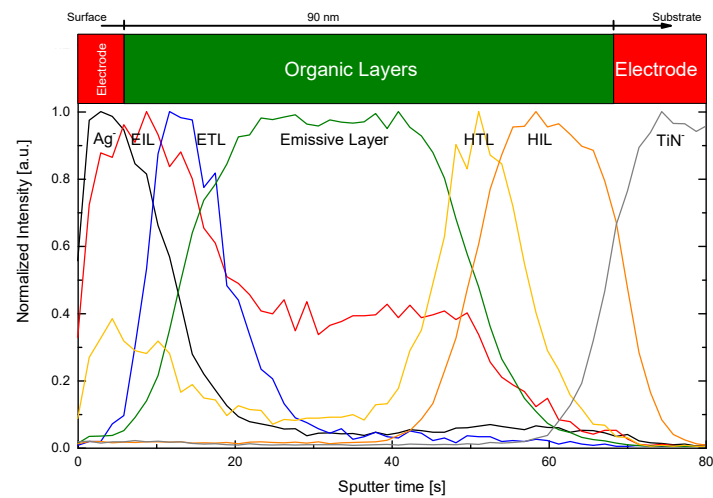
→ Loss of molecular information

2

Stripping of inorganic layers + Cluster sputtering



Sputtering Beam: **5 keV Ar₁₃₀₀⁺** (1 nA, 500 x 500 μm)
 Analyzing Beam: **15 keV Bi₃⁺** (~ 0.5 pA, 300 x 300 μm)



Information on organic layers

BEVELED CRATER ANALYSIS

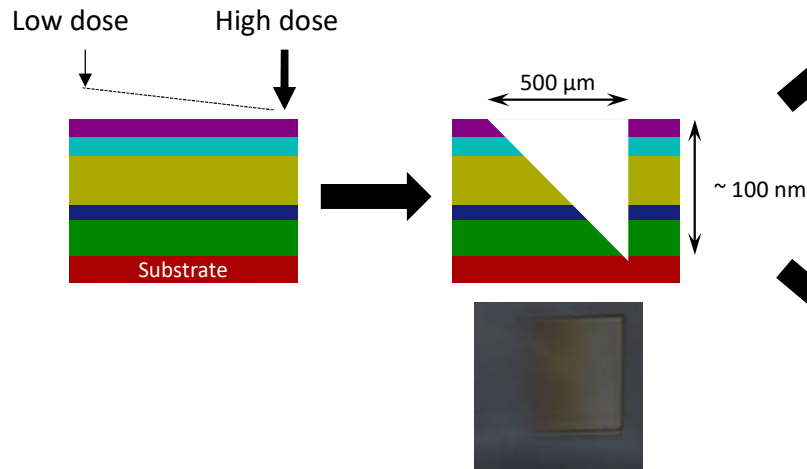
3

XPS depth profiling

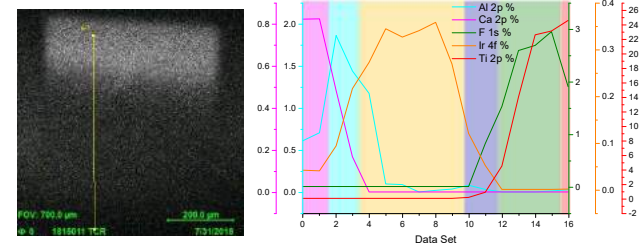
- Electron injection side is buried deep in the organic stack
- Extensive X-ray induced damage during classical depth profiling

→ Need for new characterization approach

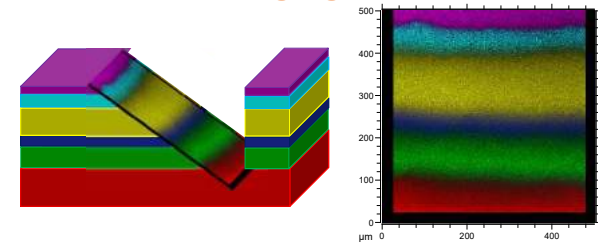
Bevel crater preparation in the ToF-SIMS instrument



XPS line scan across beveled crater



Allows at the same time for ToF-SIMS surface imaging



THANKS A LOT FOR YOUR ATTENTION!

Narciso Gambacorti

narciso.gambacorti@cea.fr

+33 6 77 38 72 65