



# JEOL réinvente sa gamme de microscopes électroniques à balayage

*Réunion pédagogique 03/12/2020*

Resolution : 500Å (25 kV)  
Magnification : x100~x100,000  
Accl. Voltage : 5 - 50 kV



**JSM-1 (1965)**



**JSM-U3 (1969)**



**JFSM-30 (1974) – First FEG**



**JSM-35 (1974)**



**JSM-840 (1982)**

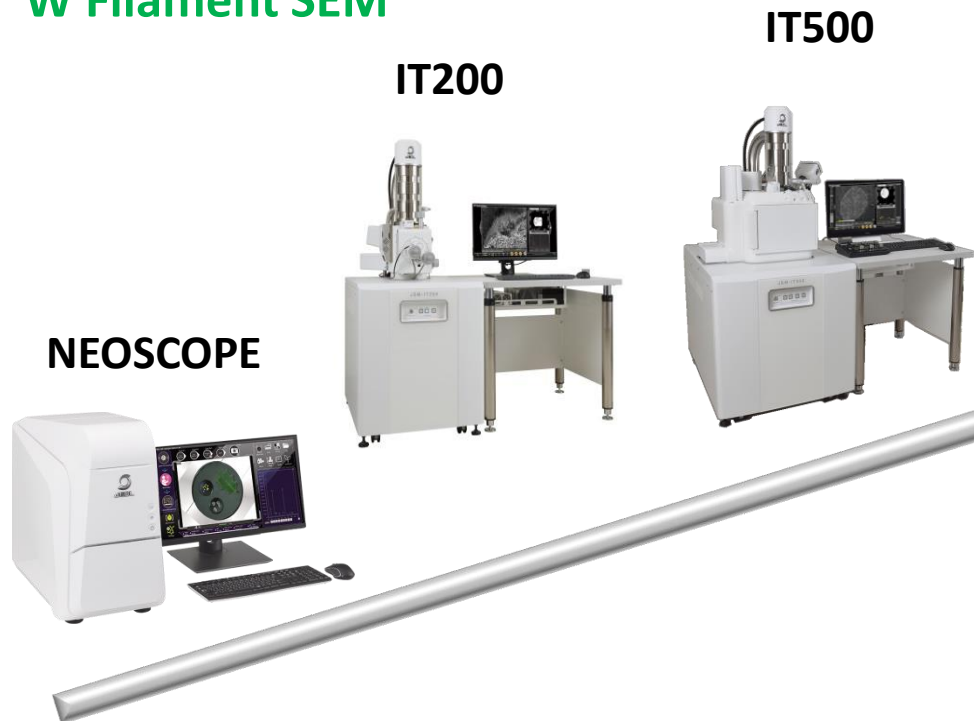


**JSM-890 (1987)**

Et au cours de ces 20 dernières années, JEOL n'a cessé d'innover :

- Dans les années 2000 :
  - Canon In-Lens Schottky FEG
  - Lentille ACL et colonne FEG à 3 lentilles condenseur
  - Gentle Beam (décélération de platine)
- Dans les années 2010 :
  - 2012 : intégration complète de l'EDS dans le logiciel du MEB
  - 2013 : filtrage des signaux SE et BSE par le détecteur In-Lens
  - 2015 : ZeroMag (passage automatique de l'imagerie optique à l'imagerie électronique)
  - 2018 : Live Map EDS

## W Filament SEM



IT700HR



IT800



IT800SHL




FE-SEM



Imagerie ET Analyse  
sans concessions

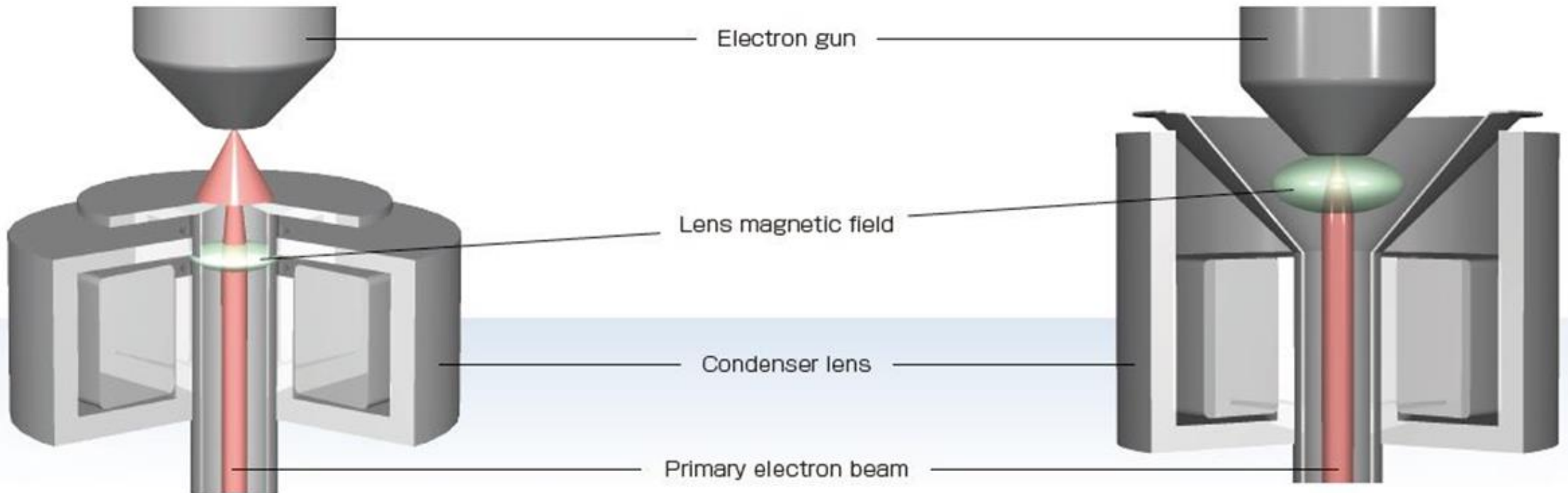
- Toute la gamme de MEB FEG JEOL garantie à la fois une capacité en fort courant (400nA à 30kV et 100nA à 5kV) **ET** la résolution ultime dans une seule configuration d'appareil



- Passez en moins de 2 minutes  
de 400nA, 30kV, x20,000  à 10pA, 1kV et une résolution sub-nanométrique

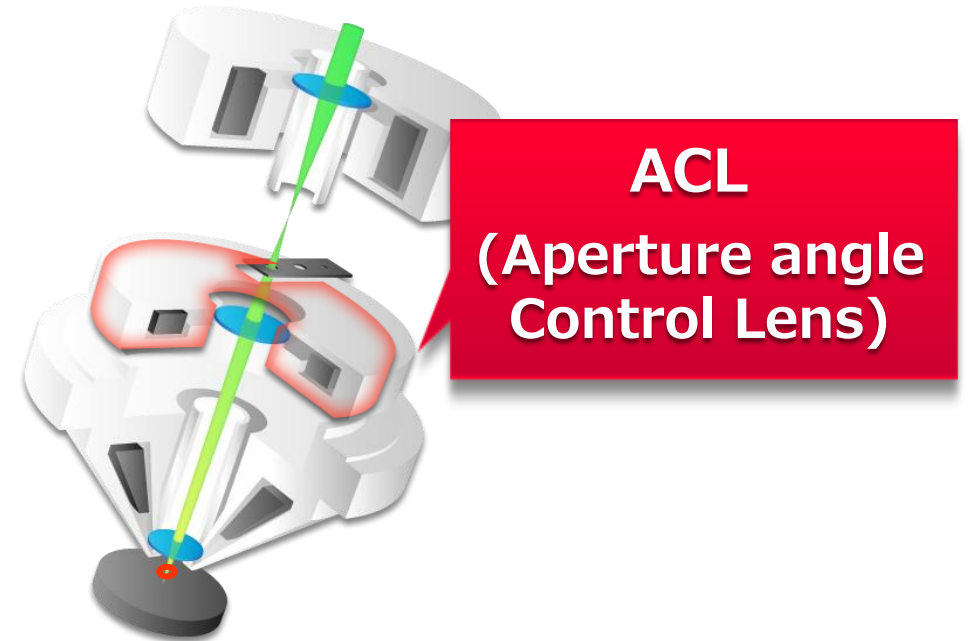
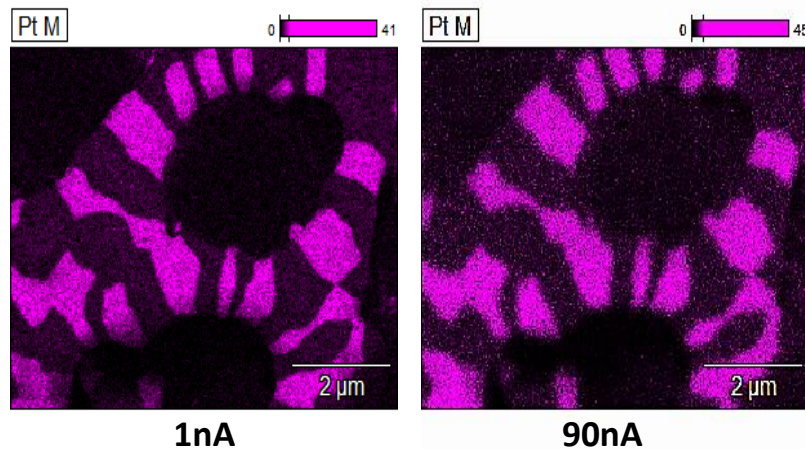
## Conventional Schottky Gun

## JEOL In-Lens Schottky Plus Gun

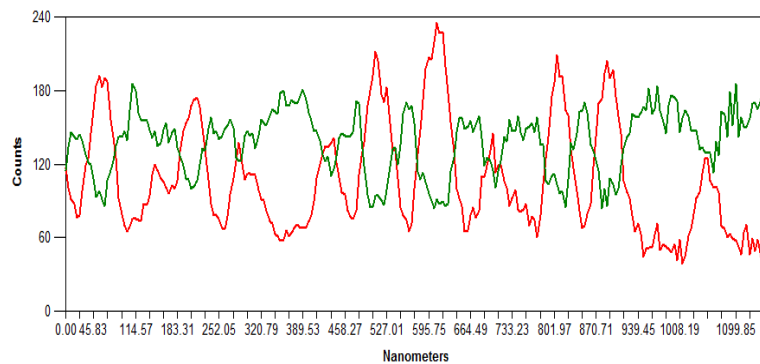
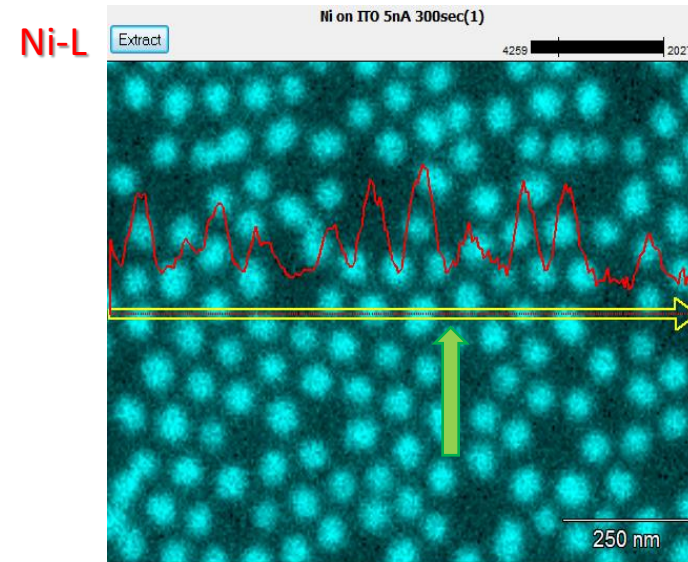
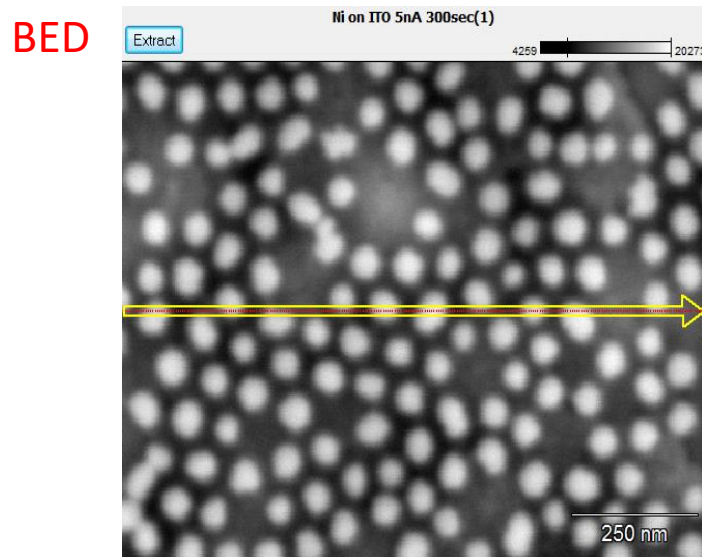


- Outre l'accélération/décélération du faisceau dans la colonne afin de minimiser les aberrations de lentilles, toutes les colonnes FEG JEOL sont également équipées de 3 lentilles condenseur
- Lentille ACL : Permet le réglage automatique de l'angle de convergence pour obtenir la plus petite taille de sonde quelque soit le courant

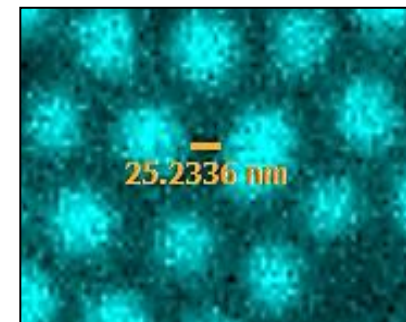
Pt EDS map  
(ceramic) 5kV



- Cartographie ultra rapide et ultra résolue à basse tension



**Ni-L**  
**In-L**

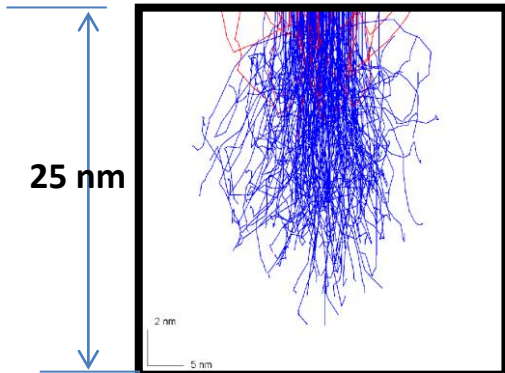
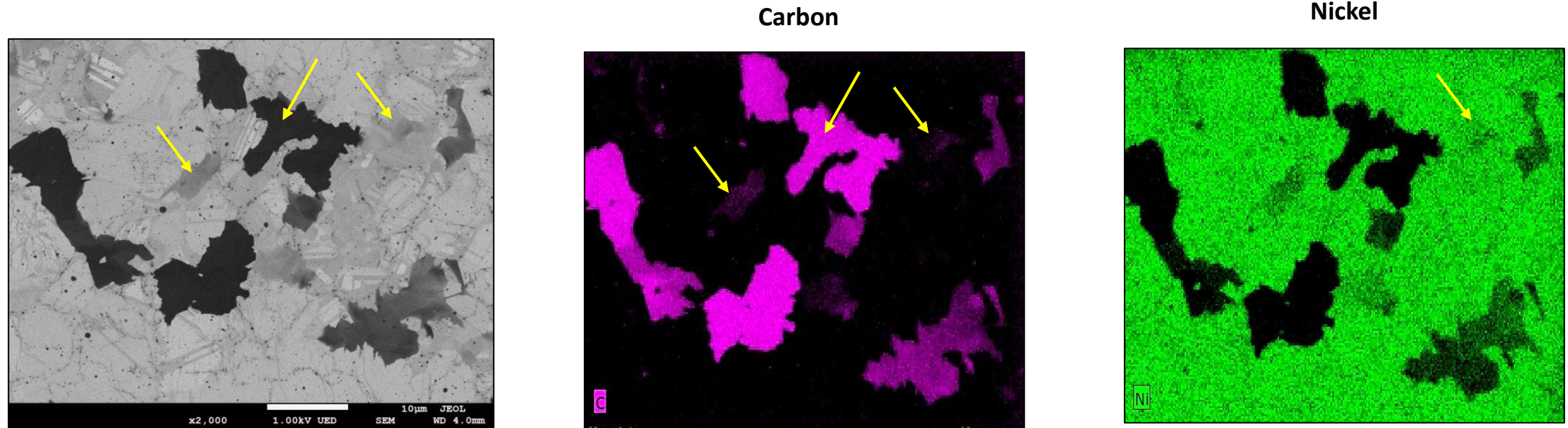


**Ni pillar on ITO: 5 kV**

**Courant de sonde: 15 nA**

**Temps : 300 sec**

- Cartographie de monocouche d'environ 20nm d'épaisseur

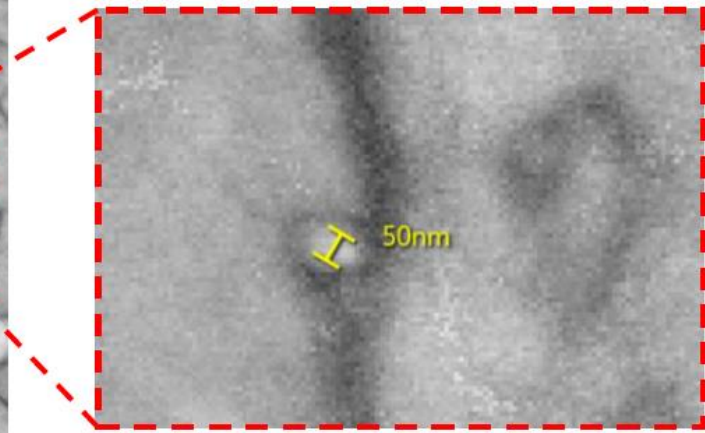
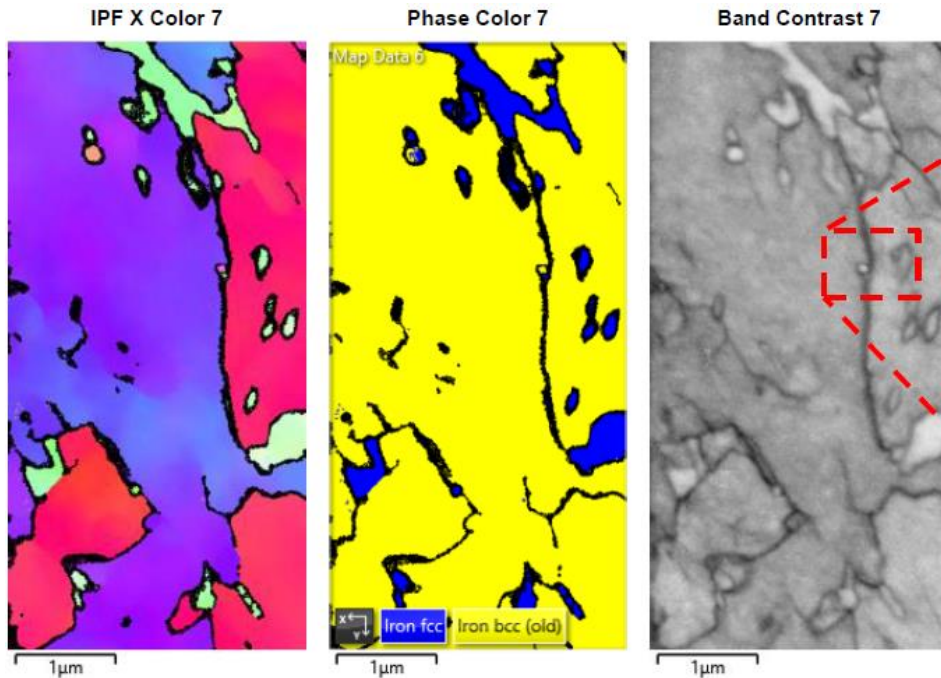


Monte-Carlo Simulation : Carbon at 1kV

L'analyse à 1kV permet de cartographier une monocouche de Graphene sur un substrat de nickel

**1 kV à 32nA pendant 15 minutes**

- L'EBSD comme le TKD bénéficie des forts courants



**40nA** de courant

Caméra CMOS Symmetry

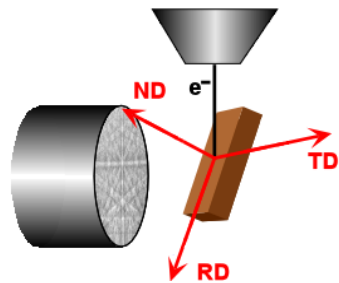
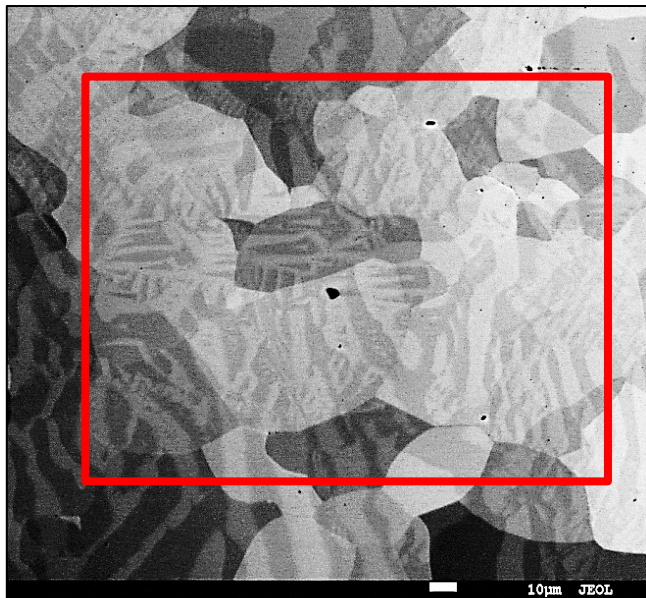
**>1000fps** en TKD

**>90%** d'indexation en **4 minutes**

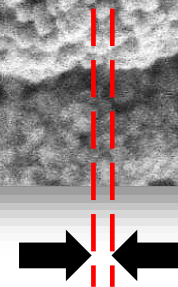
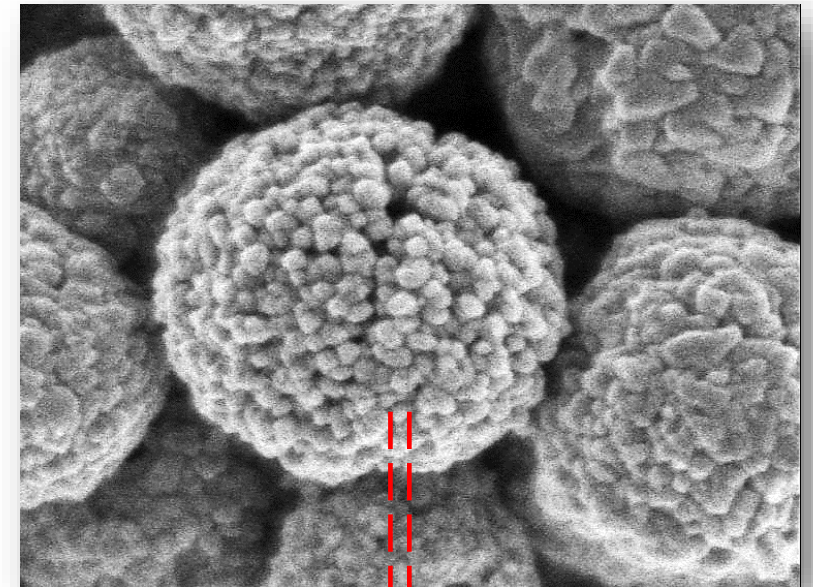
Echantillon : acier martensitique

- UHR sur échantillons magnétiques car la lentille objectif des MEB FEG JEOL n'a pas de champs magnétique débordant

*Electrical steel  
magnetic domain imaging and EBSD*

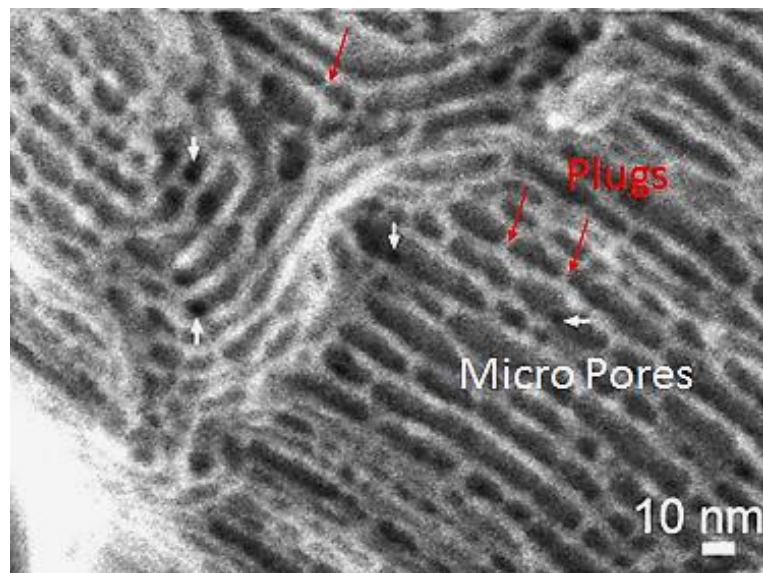


*Fe<sub>3</sub>O<sub>4</sub> Nanoparticles*



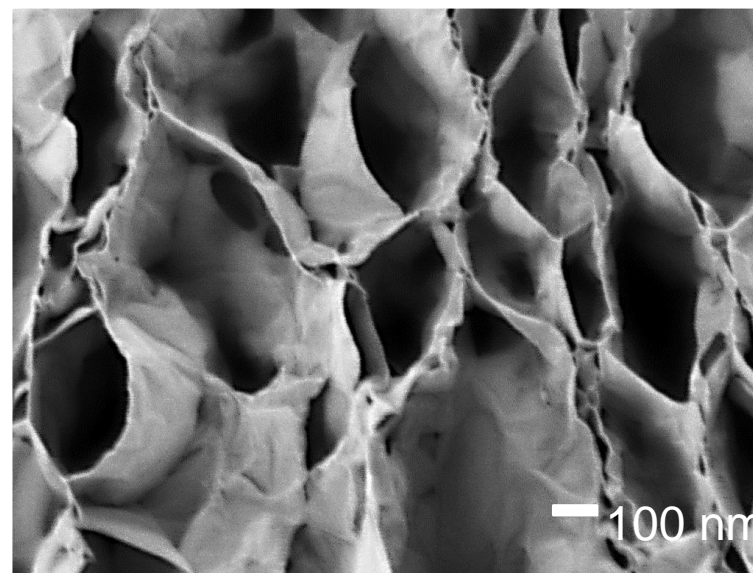
Particle size: 20 nm

- UHR sur échantillons les plus fragiles et les moins conducteurs



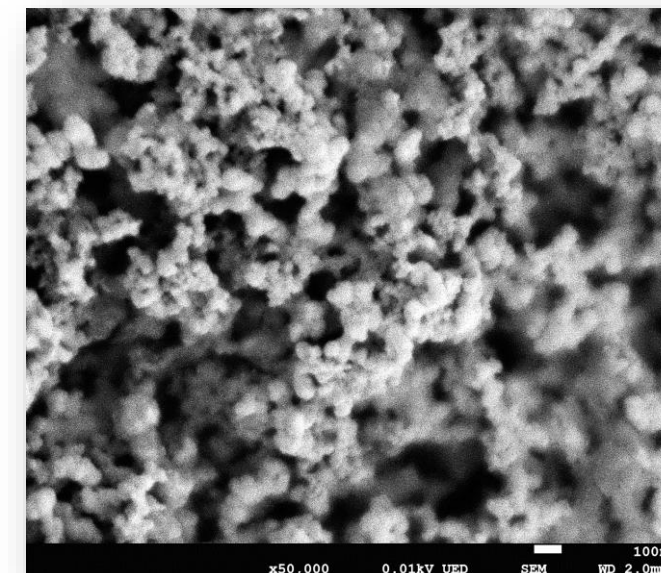
Silice mésoporeuse SBA-15  
Tension d'accélération: **300V**

*Credit: Lund University*



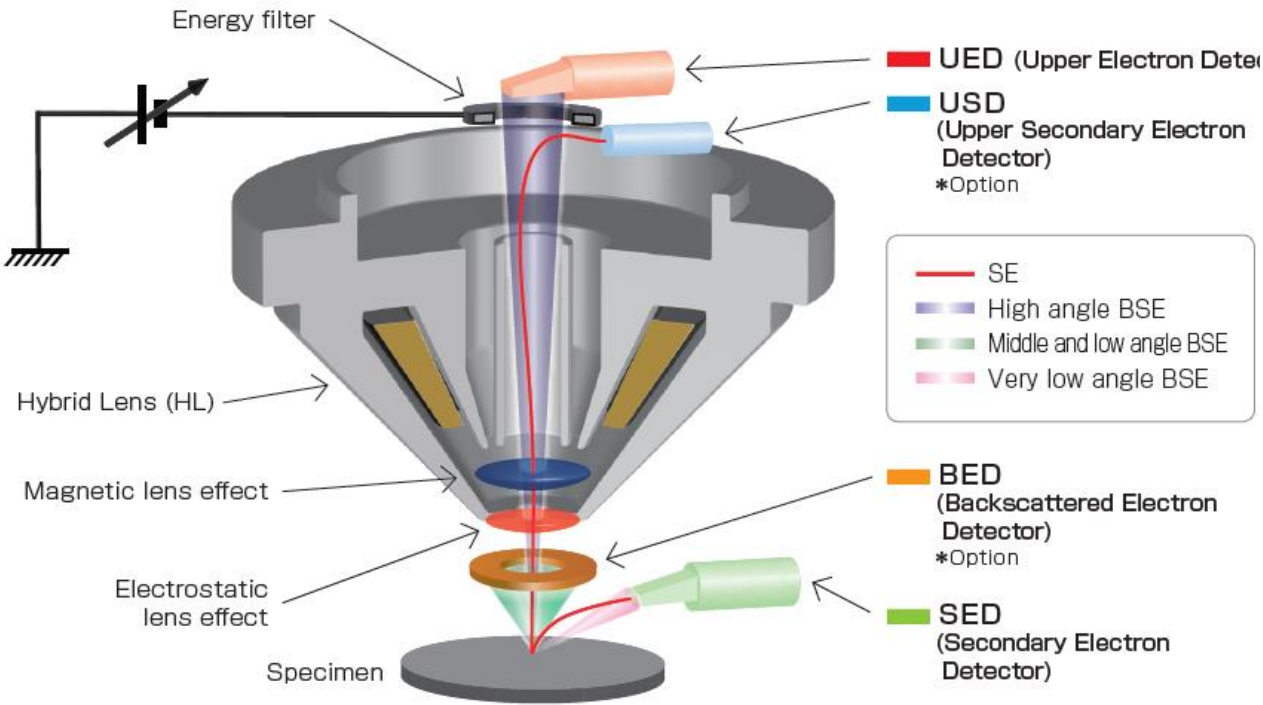
Multicouche de graphène  
Tension d'accélération: **80V**

*Credit: Harvard University*

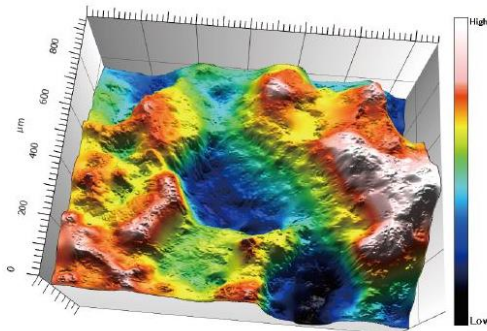


Polymère en deux phases  
Tension d'accélération: **10V**

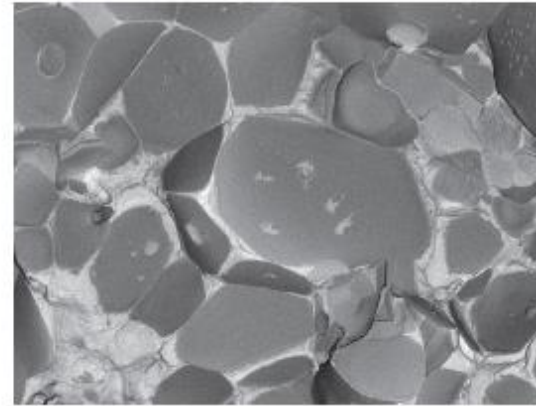
*10V / 1,3pA : 200 électrons par pixel*



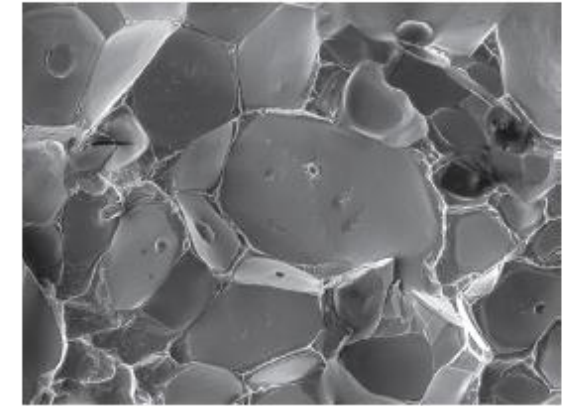
3D image obtained with SMILE VIEW™ Map \*Option



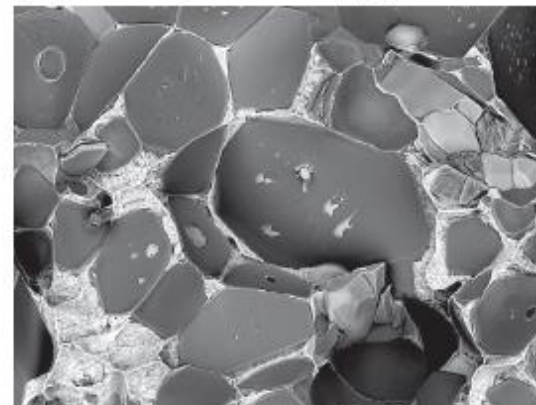
UED: High-angle backscattered electrons (compositional & crystalline information)



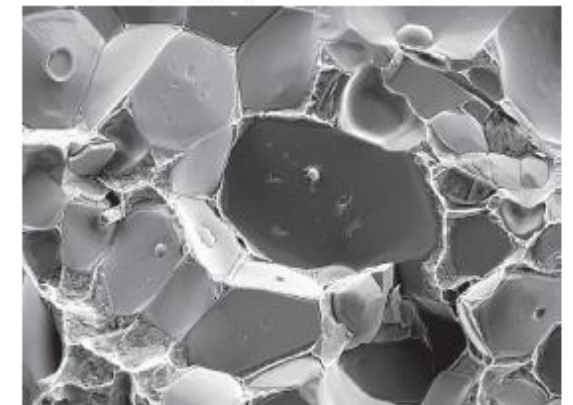
USD: Secondary electrons (surface morphological information)



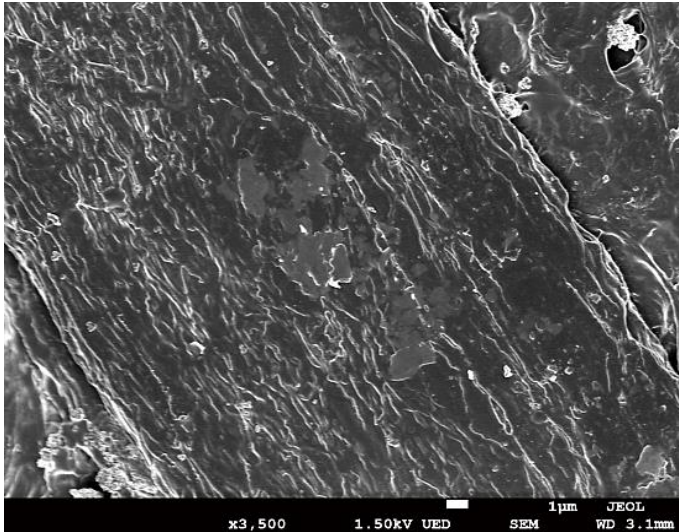
BED: Backscattered electrons (compositional, crystalline, and topographic information)



SED: Secondary and backscattered electrons (topographic information)

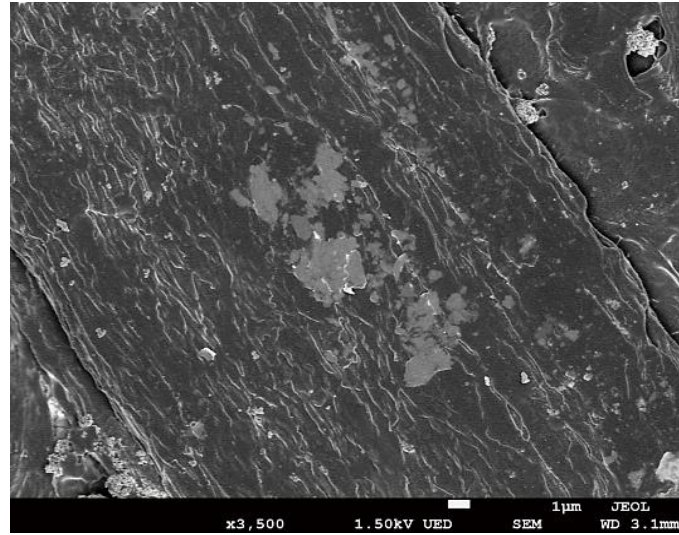


Specimen: Sintered material of Nd-Fe-B, Accelerating voltage: 5 kV, WD: 4 mm, Observation mode: HL, Energy filter: -300 V

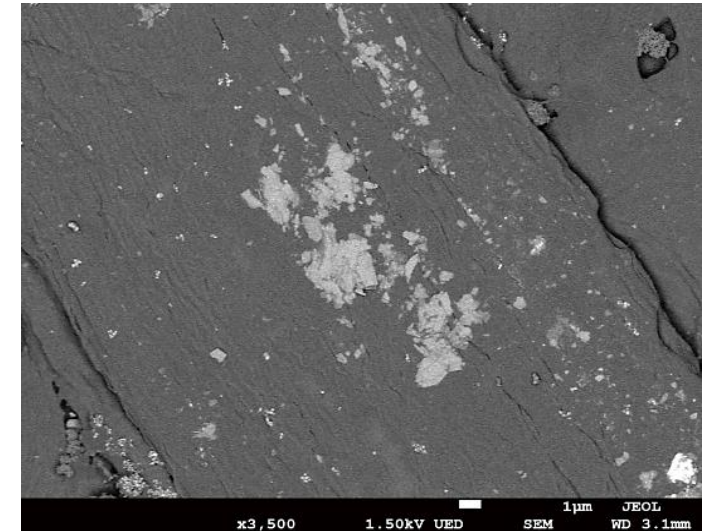


Filter set : + 0.3kV

électrons secondaires



Filter set : -0.1kV



Filter set : -1kV

électrons rétrodiffusés



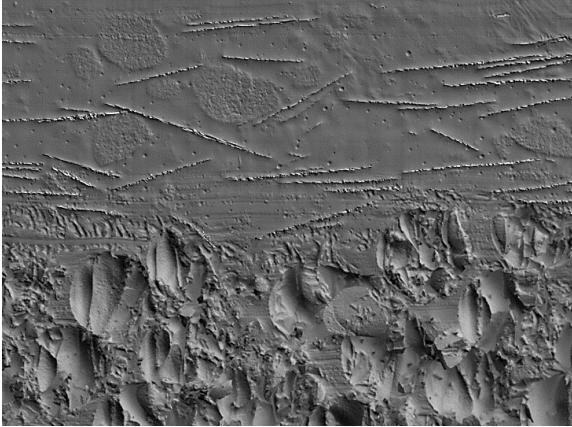
Changement continue de la valeur de l'énergie sélectionnée

Modifier la valeur du filtre d'énergie n'a aucune incidence sur la mise au point

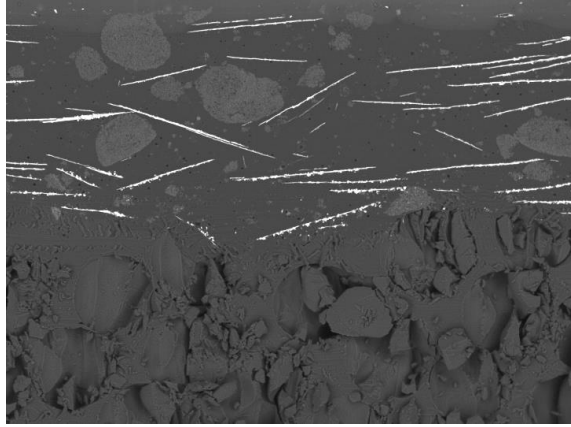
# Nouveau détecteur VBED



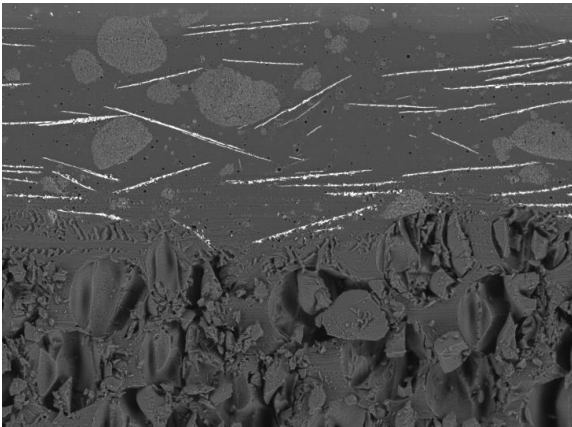
Coupe microtome du tranchant d'un club de golf à 2 kV



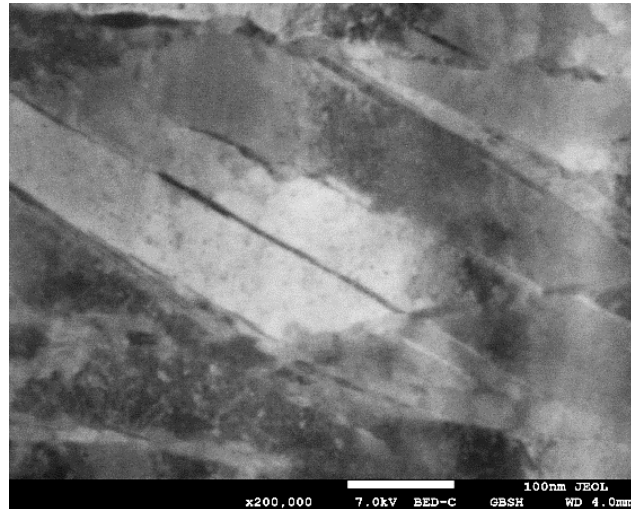
Information Topographique



Information de composition

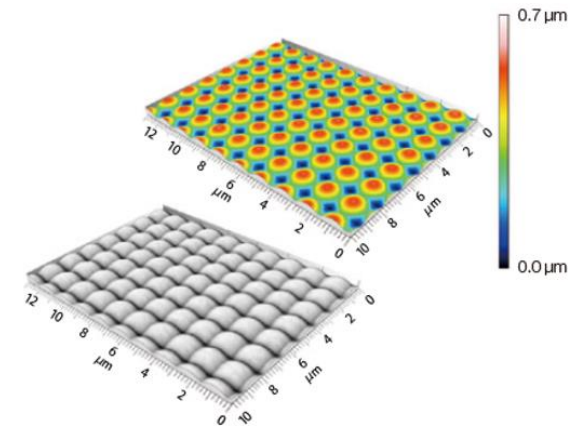
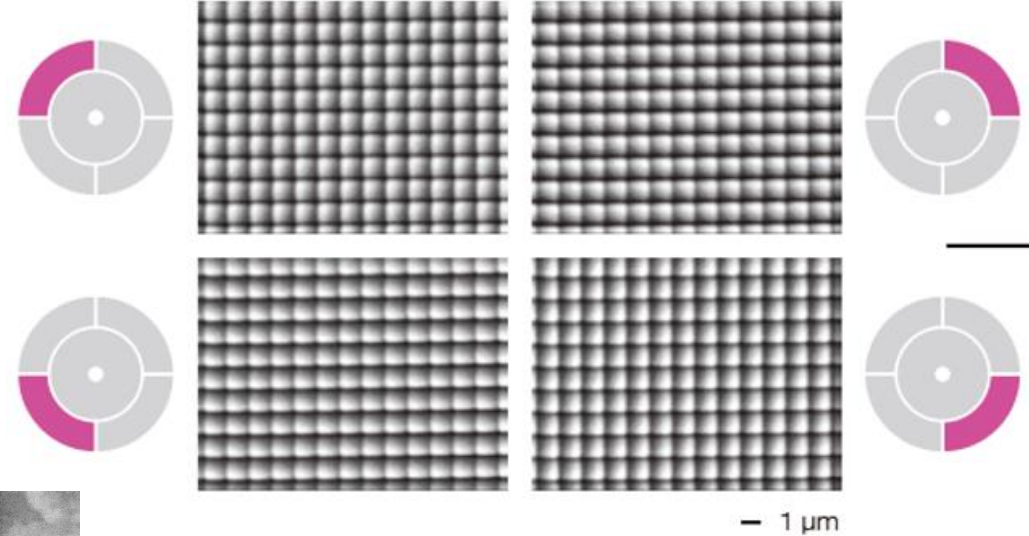


Information topographique  
et de composition

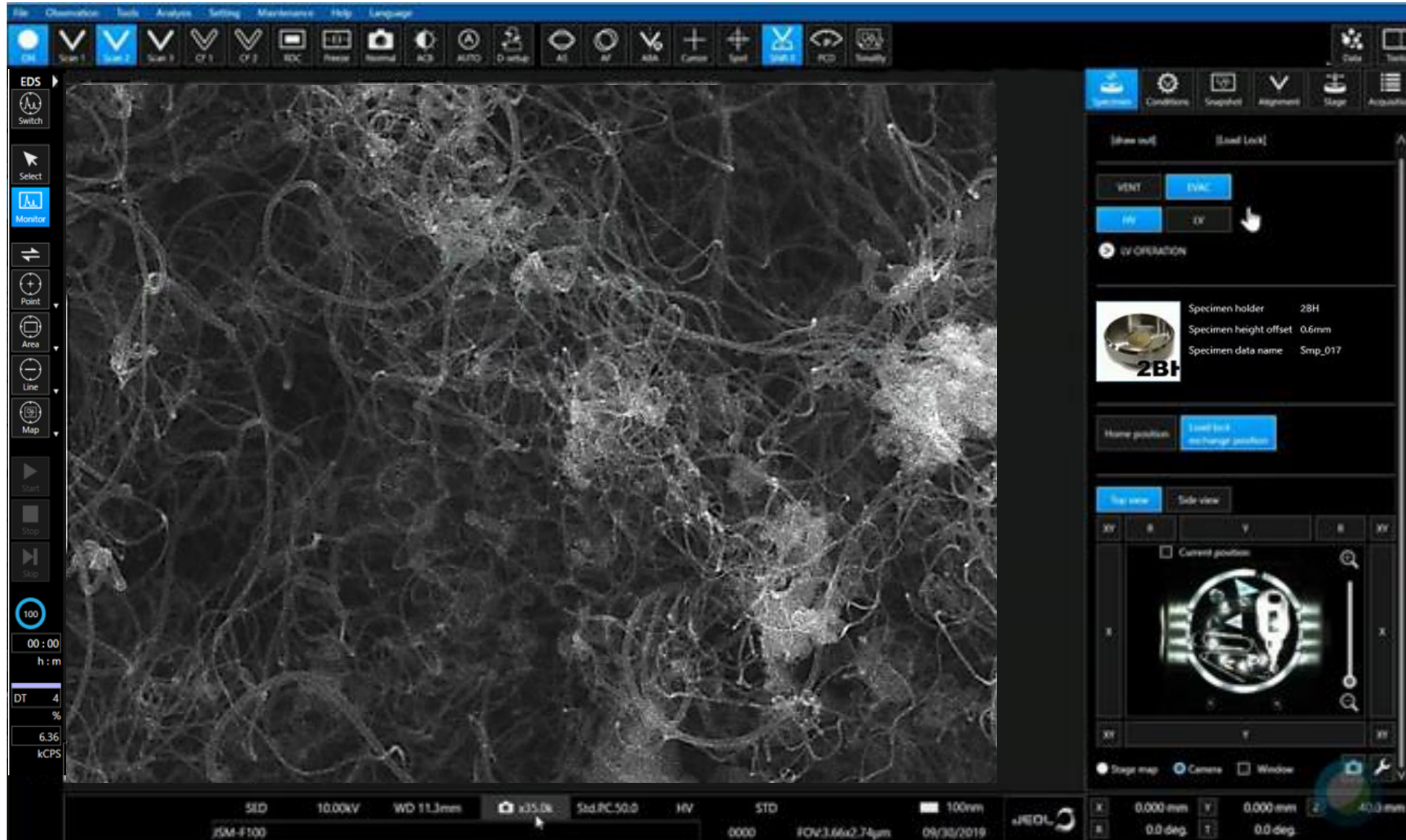


Haute résolution : acier inoxydable 7kV x200,000

Reconstruction 3D d'images



# Nouvelle interface utilisateur



- Neo Engine™, issu de cinq années de recherches JEOL, gère plusieurs centaines de paramètres en temps réel
- Les nouvelles fonctions automatiques sont performantes quelque soit les détecteurs, la tension, le courant ou la distance de travail
  - Autofocus
  - Auto contraste et brillance
  - Auto astigmatisme
  - Auto alignement du canon
  - Auto centrage du faisceau dans la colonne
  - Réglage automatique d'offset des stigmatiseurs

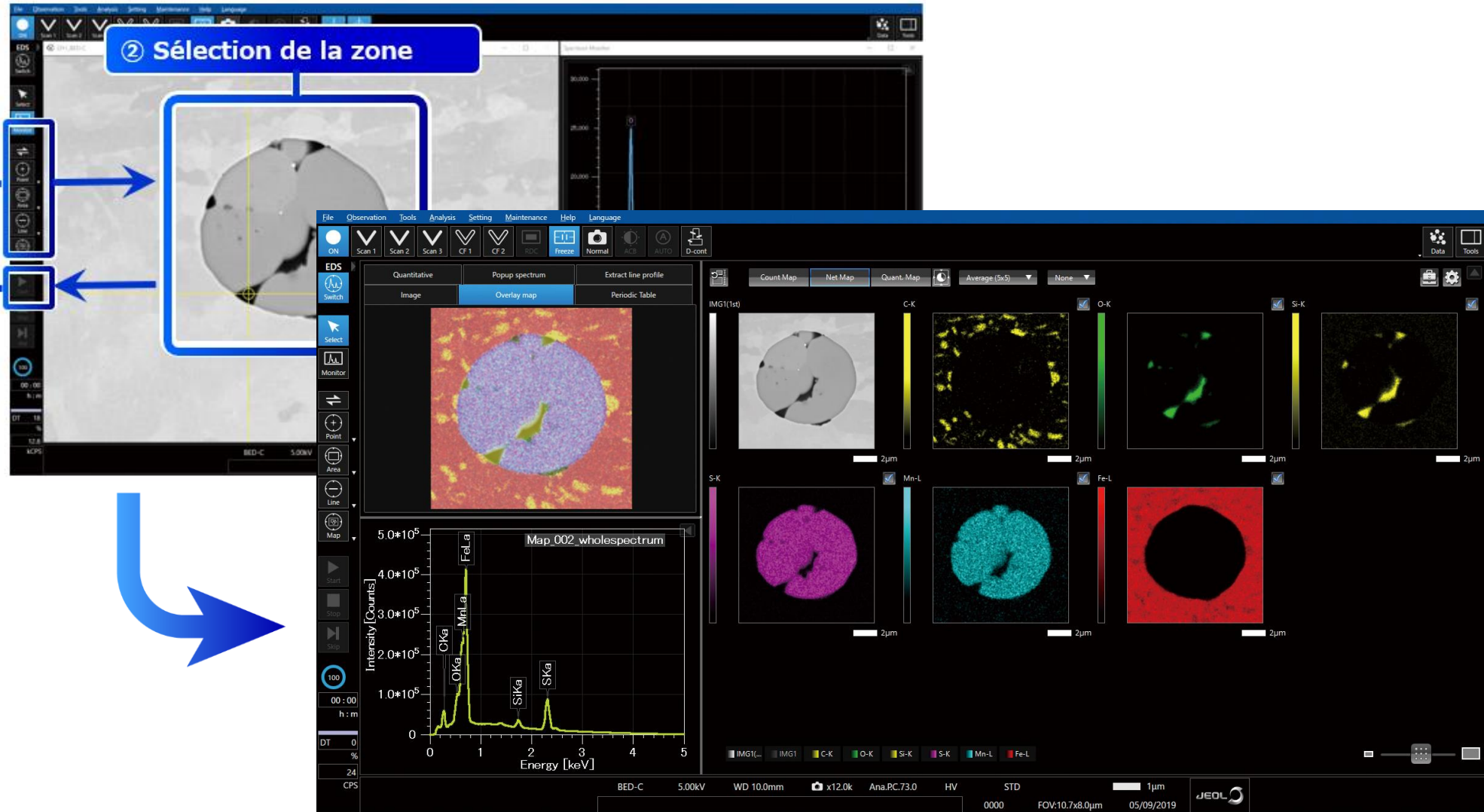
# Nouvelle interface utilisateur et EDS



① Sélection du type d'analyse

② Sélection de la zone

③ Lancement de la cartographie quantitative

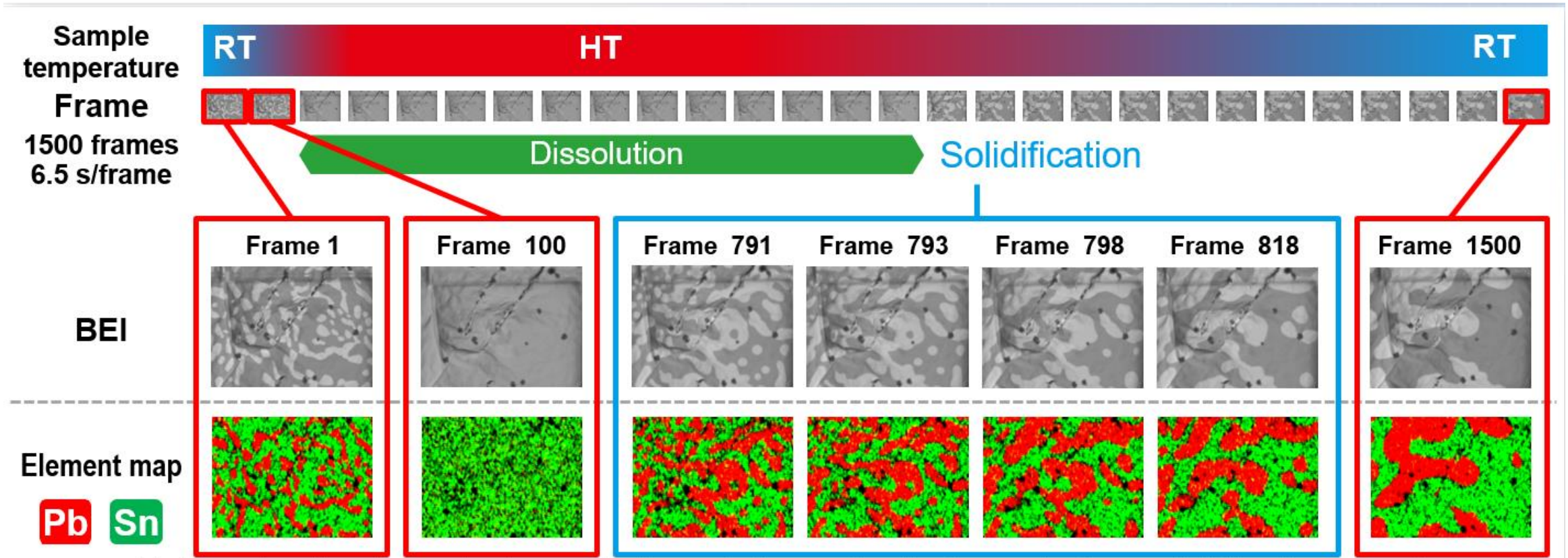


Le logiciel s'adapte automatiquement

Toutes ces fonctionnalités de l'EDS JEOL sont standards :

- Correction de dérive
- Cartographie
  - En intensité
  - Net Count Map (soustraction du bruit de fond et déconvolution en direct)
  - Quantitative
- Visual Peak ID
- Playback Analysis
- Live Map

- Playback Analysis permet d'avoir accès et d'extraire chacune des frames qu'il y a eu au court de la cartographie



Soudure Pb-Sn : 7kV / x10,000 / porte-objet chauffant Aduro 100

# Live Map



The screenshot displays the JEOL software interface for a scanning electron microscope (SEM) equipped with an energy-dispersive X-ray (EDS) detector. The main window, titled "Live Map", shows a color-coded map of a sample surface. The map is primarily red, with blue and yellow-green patches. A legend on the right side of the map window lists the elements being tracked: IMGI (Secondary Electron Image), C K (Carbon), O K (Oxygen), and Mg K (Magnesium). The O K and Mg K elements are currently active, as indicated by the checkmarks and the corresponding colors in the map.

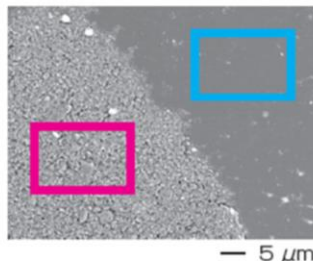
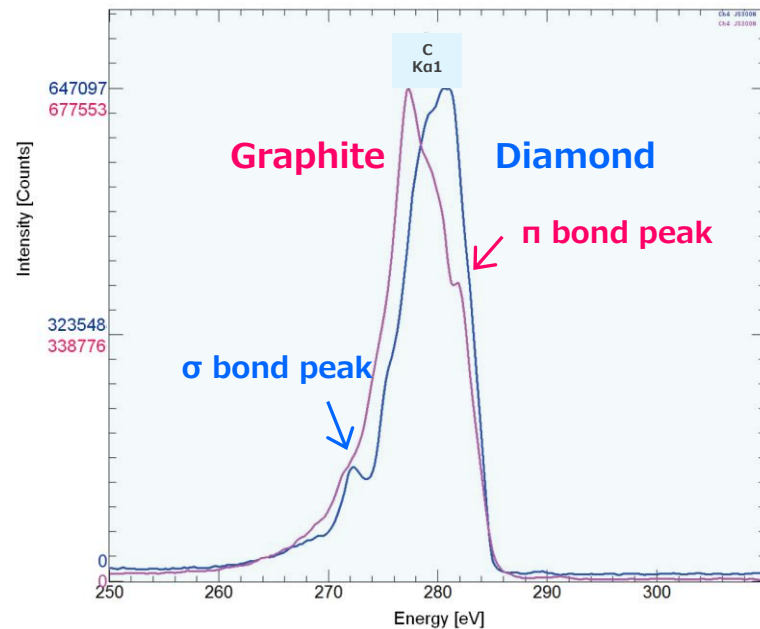
Below the main map, there are four smaller windows showing individual elemental maps: IMGI (Secondary Electron Image), C K (Carbon), O K (Oxygen), and Mg K (Magnesium). Each of these windows has a 20µm scale bar. The O K map shows blue patches, and the Mg K map shows red patches, corresponding to the colors in the main Live Map.

The software interface includes a top menu bar with options like "File", "Observation", "Tools", "Analysis", "Setting", "Maintenance", "Help", and "Language". Below the menu bar is a toolbar with various icons for camera control, analysis, and image processing. On the right side, there are panels for "Snapshots" and "Thumbnail". The bottom status bar displays technical parameters: SHD, 10.00kV, WD 10.0mm, x1.50k, Ana.P.C.80.0, HV, S11, 5µm, JEOL logo, and coordinates: X: -2.405 mm, Y: 0.325 mm, Z: 10.1 mm, T: 180.0 deg. The date and time are 11/24/2020 09:46:00. A note at the bottom left states: "11/24/2020 09:46:00 The detector of ch1 was set to SED."

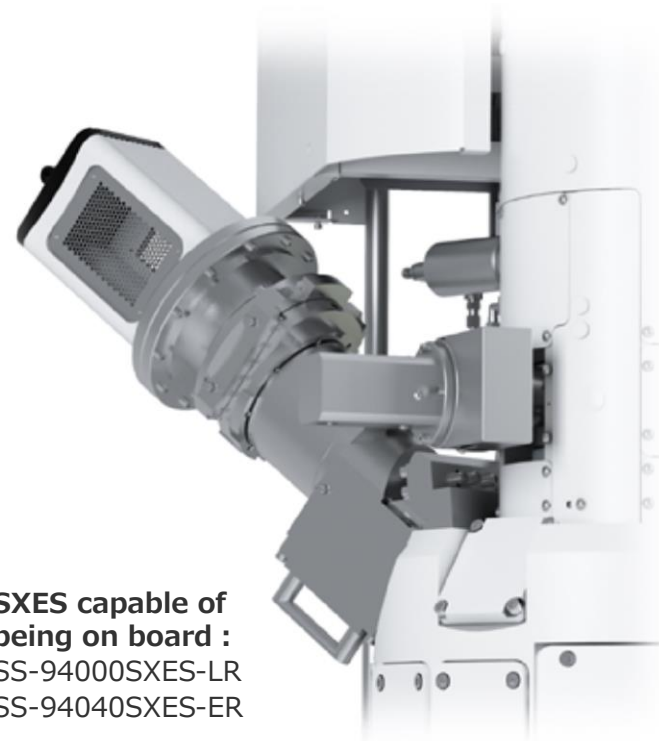
# SXES : Soft X-Ray Emission Spectrometer



The Soft X-ray Emission Spectrometer (SXES) delivers extremely high sensitivity and energy resolution, allowing for chemical-state analysis, as well as elemental analysis. Incorporation of the SXES in the FE-SEM makes it possible to analyze local areas at high probe current.



Specimen: Diamond and graphite  
Accelerating voltage: 2 kV  
Probe current: 36 nA  
Detector: SXES-ER



**SXES capable of being on board :**  
SS-94000SXES-LR  
SS-94040SXES-ER

At C-C single bond ( $\sigma$ -bond) and C-C double bond ( $\pi$ -bond), peak top shifts and different shoulder peaks were confirmed in the C-K $\alpha$  first-order line spectra. The use of SXES reveals the difference in spectral shapes originating from chemical shift, even when the two spectra are acquired from the same type of carbon.

# SXES : Soft X-Ray Emission Spectrometer

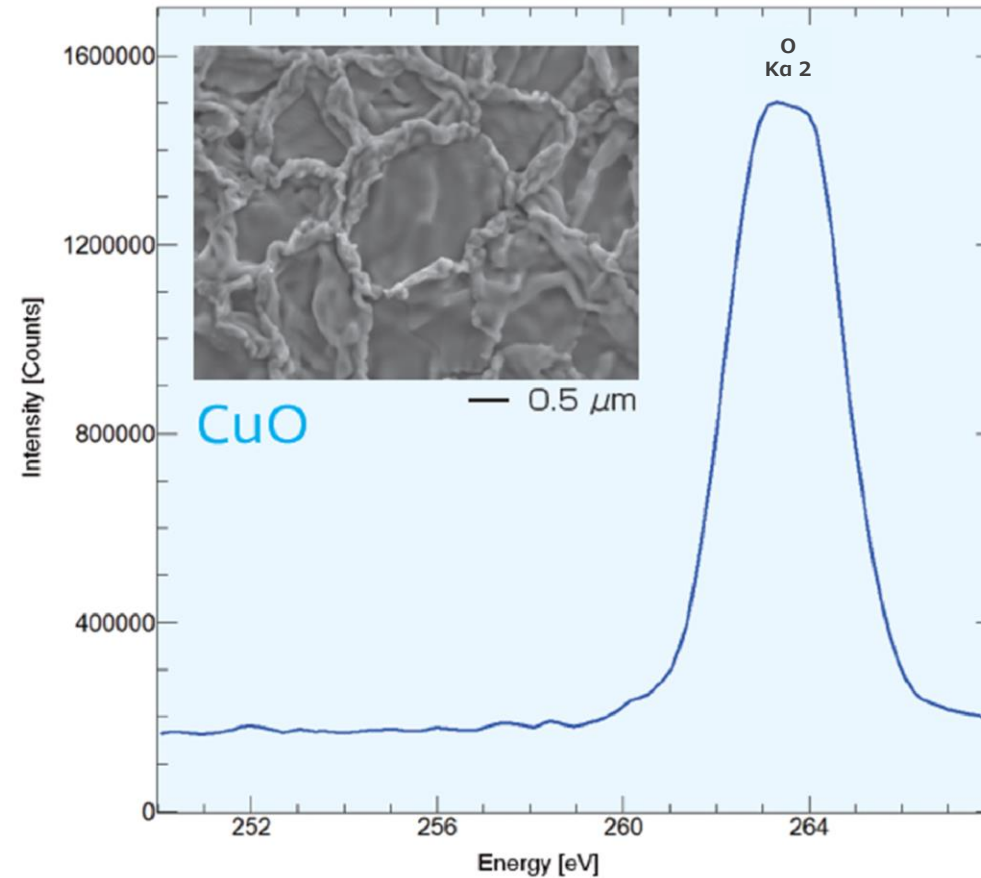
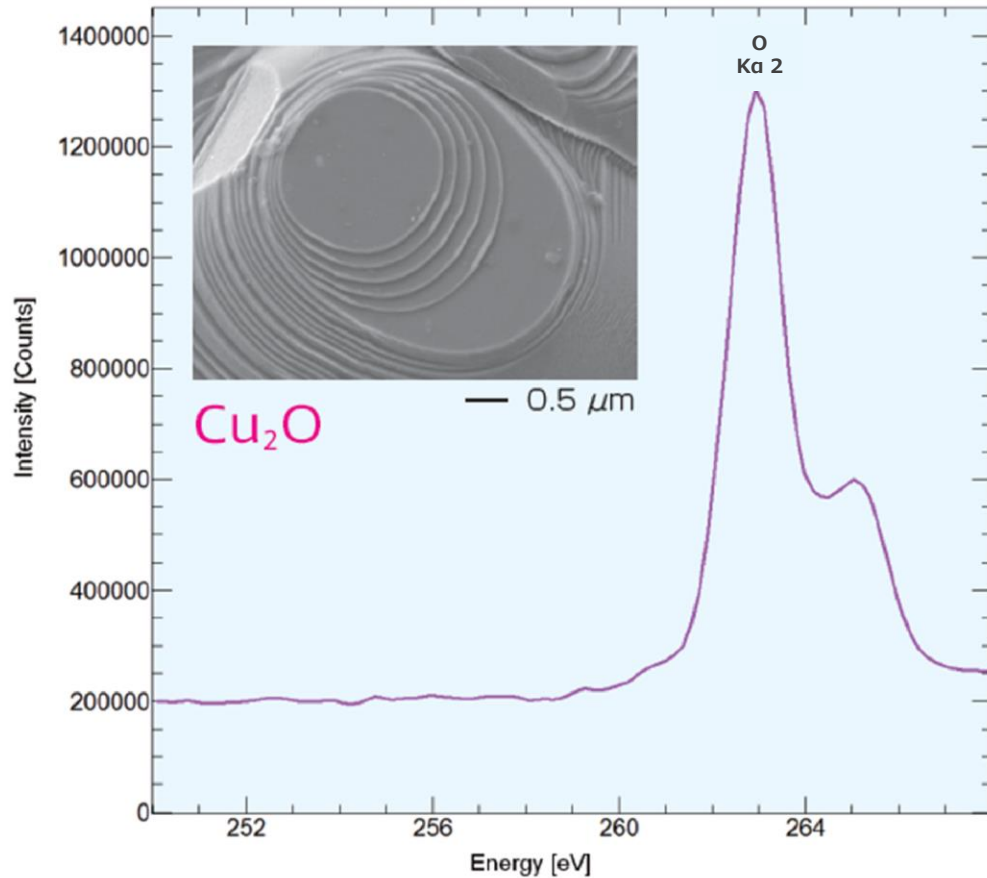


Characteristic	SXES	EPMA (WDS)	EDS
Energy resolution	<b>0.3 eV</b> Al-L, Fermi edge of metallic aluminum	<b>8 eV</b> Fe-K $\alpha$ FWHM LiF analyzing crystal	<b>125 eV</b> Mn-K $\alpha$ FWHM
Chemical bonding state analysis	<b>Yes</b>	<b>Possible</b> (mainly light elements)	<b>No</b>
Parallel detection	<b>Yes</b>	Limited to the number of spectrometers	<b>Yes</b>
Analyzer element & detector	<b>Grating + CCD</b>	Analyzing crystal + Proportional counter	<b>SDD</b>
Quantitative Analysis	<b>Possible</b>	<b>Yes</b>	<b>Yes</b>
Limit of detection (Ref. value of boron)	<b>20 ppm, B</b>	<b>100 ppm, B</b>	<b>5000 ppm, B</b>

# SXES : Soft X-Ray Emission Spectrometer



- Comparison of monovalent  $\text{Cu}_2\text{O}$  and bivalent  $\text{CuO}$  spectra. Due to the difference in electronic structure, the difference in spectral shapes in the O-K $\alpha$  second-order line spectra was confirmed



Specimen:  
Copper oxide  
Accelerating  
voltage: 5 kV  
Probe current:  
100 nA  
Detector:  
SXES-ER

**Je laisse maintenant la main à mes collègues Ingénieurs Applications**

**Franck Charles , Jean-Claude Menard et Yusuke Uetake**

**pour une démonstration en direct de notre centre de démonstration**

**de Croissy-Sur-Seine**



**Merci !**

**Des questions ?**