Scanning Electron Microscopy Equipment (SEM)

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Scanning electron microscopy (SEM) is one of the most used characterising tools within material research because for a whole range of different industrial/research sectors information can be obtained from macro down to nano scale. During a SEM study a focused electron beam is scanned upon the surface of the material under study and generates different signals (SE, BSE, X-rays, light,…) which can be picked up by different detectors to build images, maps and/or spectra.

Nowadays a variety of detectors are available to obtain besides the classical imaging modes (SE : Secondary Electrons and BSE : Back Scattering Electrons) also a lot of information about the chemical composition (EDX : Energy Dispersive X-ray detection), the crystal structure (EBSD : Electron BackScatter Diffraction), the presence of defects / dopants (CL : CathodoLuminescence; EBIC : Electron Beam Induced Current),…. The lateral resolution of the SEM technique in imaging mode can be in the order of 1 nm in SE mode.

Nowadays SEM's are also operational in three vacuum modes (high vacuum, low vacuum and ESEM (environmental SEM)) to accommodate the widest range of samples. The digitized SEM allows continuous imaging to perform in-situ SEM studies of dynamical processes.

Due to its versatility Scanning Electron Microscopy can be used in many research domains (materials science, chemistry, pharmacy, biology, geology…). Depending on the information to be gathered studies are carried out on a non-destructive or destructive way (e.g. embedding in a resin followed by polishing treatment, decapsulation, cleavage,…).

Some typical examples are : inspection of microelectronic devices at the surface and in cross-section; evaluation of coatings, corrosion study; failure analysis; chemical analysis; first check of RoHS compliancy of materials,…

System description and specifications

IMOMEC has two scanning electron microscopes with a field emission gun (Philips XL30 FEG-SEM and FEI Quanta 200 FEG-SEM) both equipped with an EDX system with a Si(Li) detector with EDAX or Bruker software..

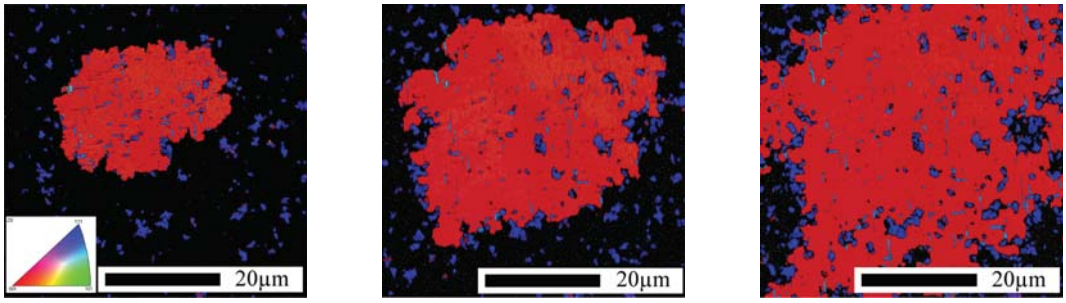
The Philips XL30 FEG-SEM is equipped with a wafer prober with electrical connectors and/or 4 needles combined with a heating facility and an automated recording system allowing the study of dynamical processes as electromigration in interconnecting lines, grain growth in metallizations (e.g. Cu). Also the CL detector is available on this SEM.

The FEI Quanta 200 FEG-SEM is a versatile high resolution scanning electron microscope with three vacuum modes (high vacuum, low vacuum and ESEM (up to 40hPa)) to accommodate the widest range of samples of any SEM system. The crystallographic information of crystalline materials can be obtained with the EBSD system (Oxford Instruments (former HKL Technology) with NordlysII detector). The Quanta 200 FEG-SEM has additionally an electron beam lithography system (JC Nabity). Samples up to 3 kg can be mounted upon the specimen stage. Both FEG-SEM's are foreseen with own developed software to perform drift corrected dynamical experiments. In this way in-situ SEM experiments are available.

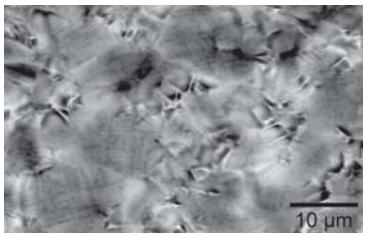
Measurement example

Some typical applications are, most of them at surface and/or cross-sectional view :

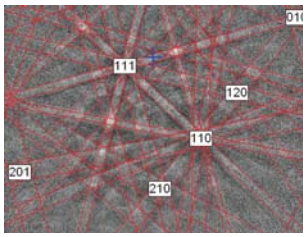
- inspection of microelectronic devices
- evaluation of coatings : topography, layer build-up, composition
- corrosion study
- failure analysis
- chemical analysis (point, mapping,...) to reveal compositional changes within materials
- first check of RoHS compliancy of materials
- crystallographic information of (poly-)crystalline materials : crystal structure, grain size, orientation
- dynamical experiments (e.g. electromigration, grain growth,…)
- EBIC measurements to reveal dopant differences in semi-conductors
- Electron beam lithography



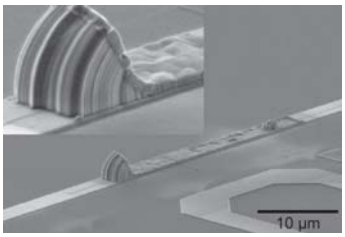
Study of grain growth in electroplated (ECD) copper films upon thin Cu PVD coated substrates : EBSD maps of a 500nm Cu seedlayer (50W) on a 10nm TaN/5nm α-Ta barrier (100W) taken respectively 4 days, 1 week and 2 weeks after deposition



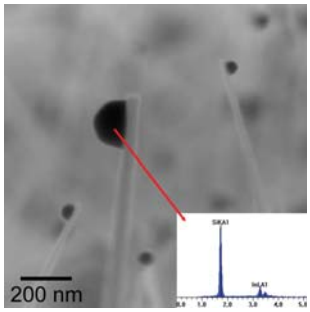
EBIC at doped Si layers upon ceramic



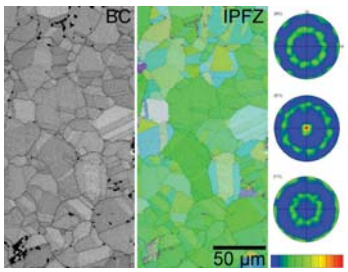
EBSD pattern of Si grain



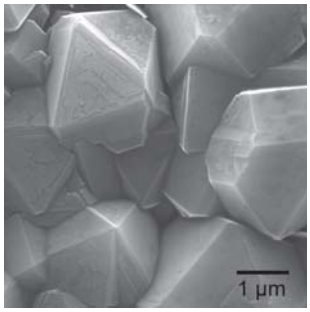
Electromigration on Al Blech structure



Si nanowires with In catalyst on the top



EBSD study on CVD diamond film



CVD diamond film

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