FAILURE ANALYSIS LAB

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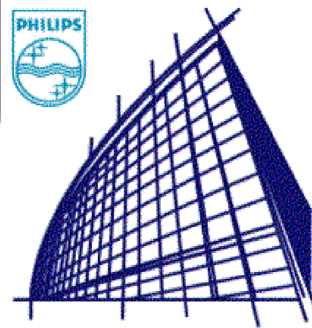


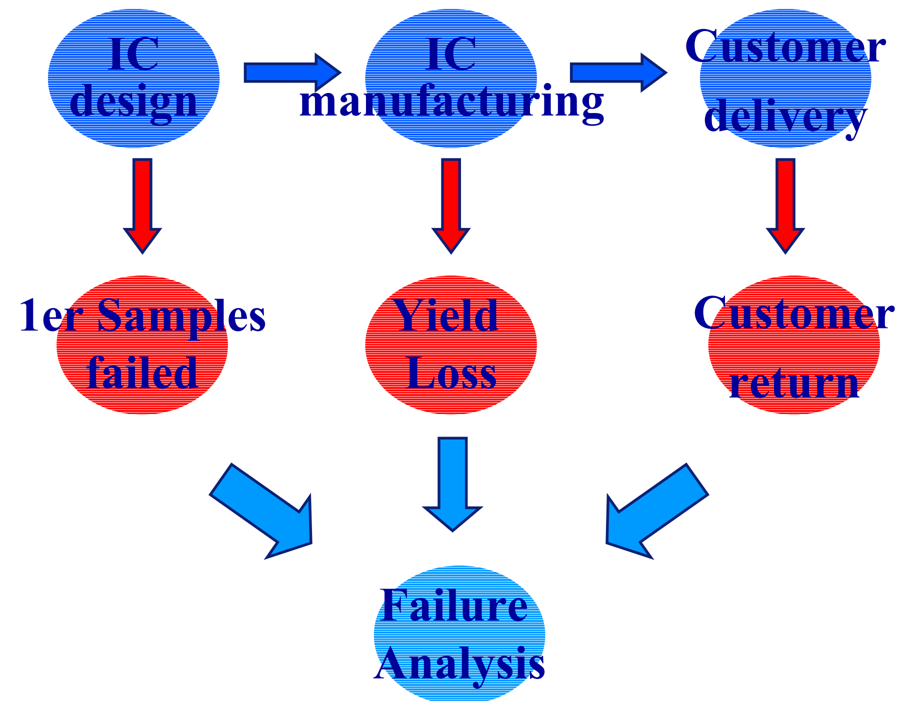
LaMIP

Laboratoire de Microélectronique ISMRA PHILIPS

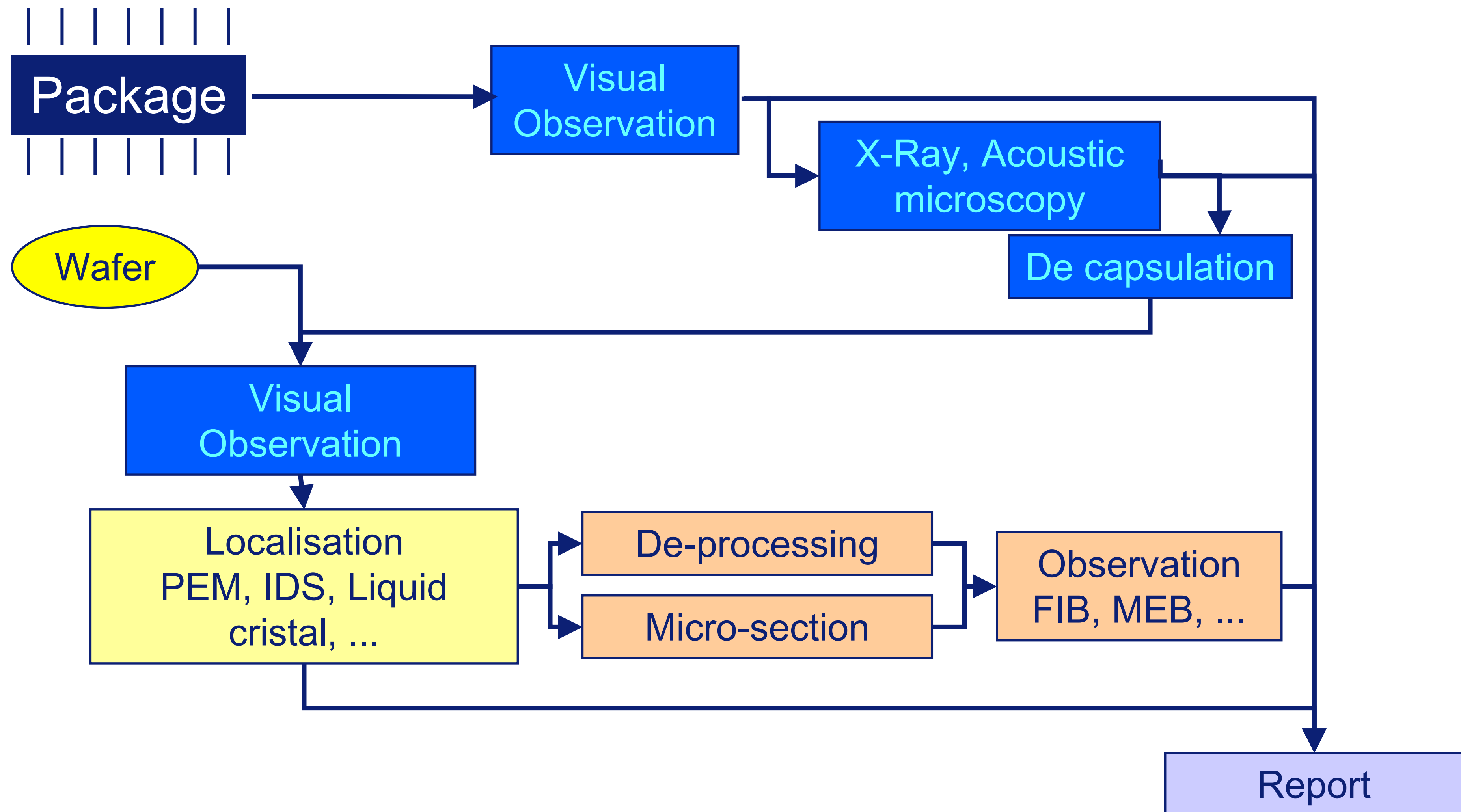
Failure Analysis activities

- Why do we need to perform electrical and physical analysis ?
  - No production with zero default.
  - Not always direct access to all blocks of current VLSI chip (size, number of transistor, number of IO pins available).

- Analysis is needed at different step of the product life
  - to debug first engineering samples.
  - to analyse rejects after wafer or final test.
  - to analyse customer returns.
  - Reverse engineering

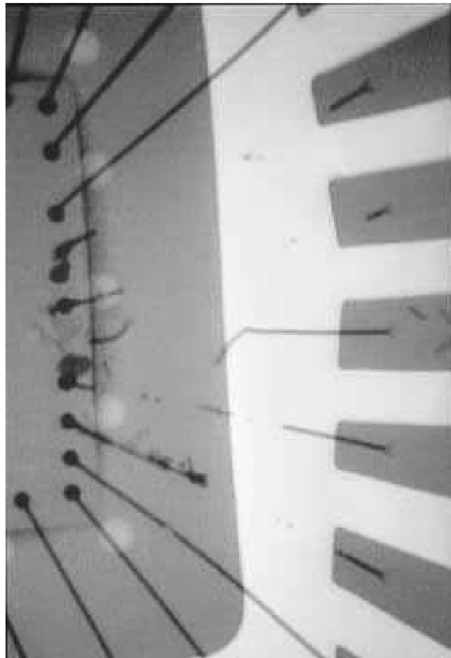


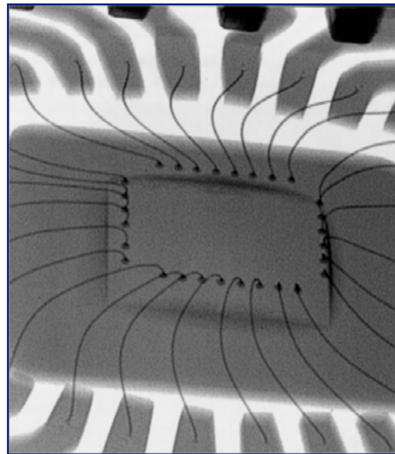
Failure Analysis Process



Non destructive analysis : X-Ray

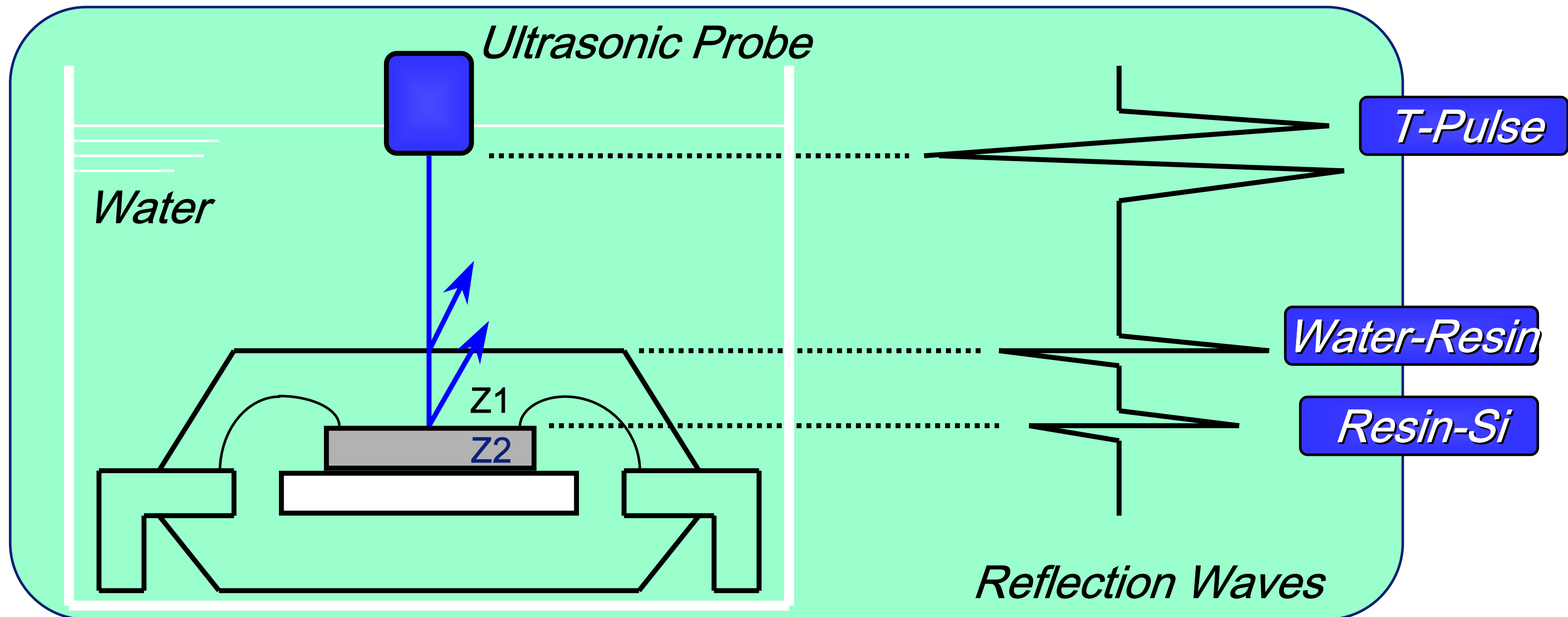
This non-destructive system allows direct observation of a packaged die through the plastic (Die crack, pop corn, assembly defects, …)





Acoustic Microscopy

characteristic of ultrasonic



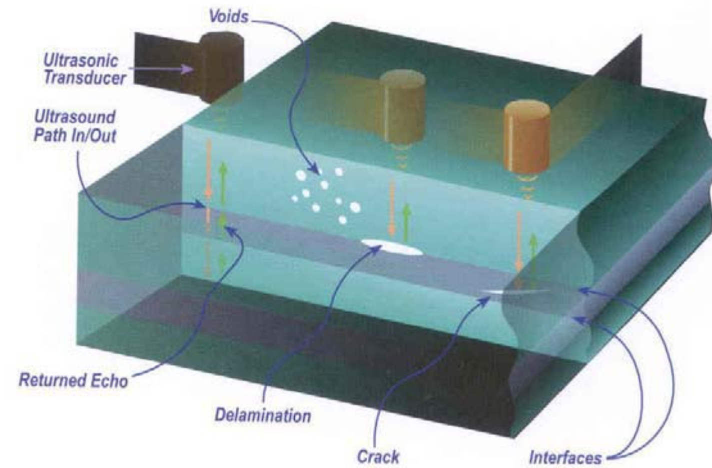
$$\text{Reflection ratio } R = \frac{Z2 - Z1}{Z1 + Z2}$$

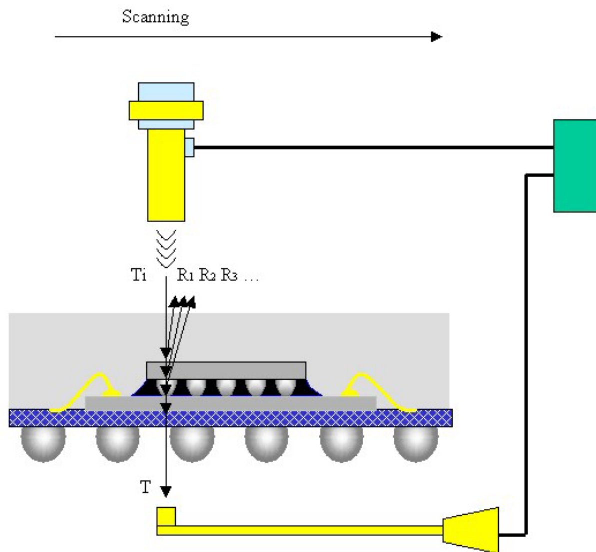
Z1:Acoustic Impedance of medium1
Z2:Acoustic Impedance of medium2

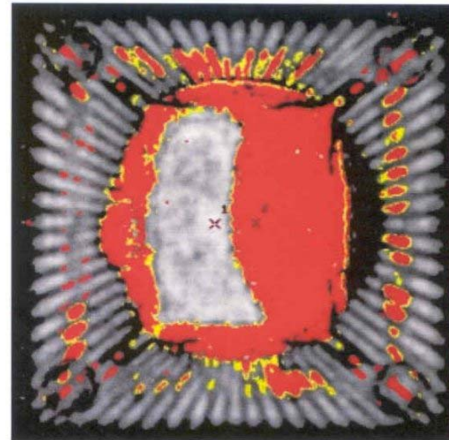
Z=(Density) X (Sound velocity)

The C-SAM provides non-destructive image of :

- Cracks
- Delamination
- Voids
- Tilt
- Moisture/thermal induced damage



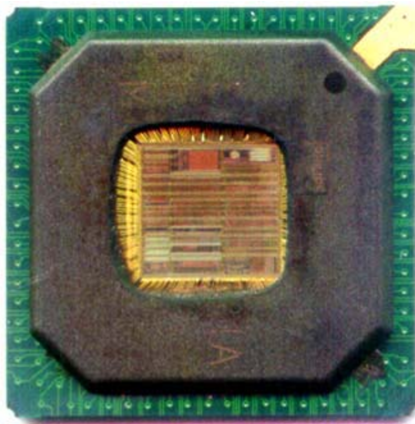


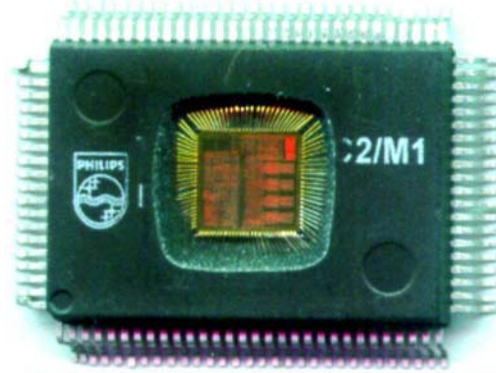


Preparation Equipment

Package de-capsulator

AS2000 allows to open all standard plastic with nitric acid at 70C
BG Dcap allows to open new BGA types.



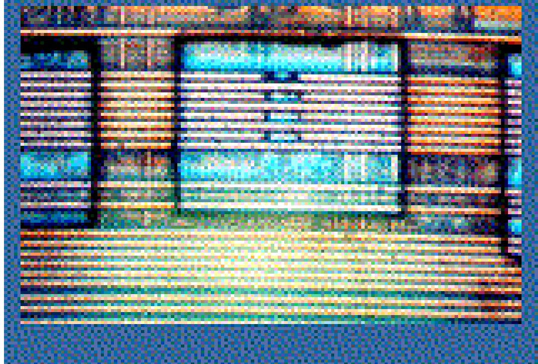


Preparation Equipment

Laser cutter

Cut metal line (AL, Cu, Or) from 0,7µm to 50µm wide, open window in passivation and oxide layer

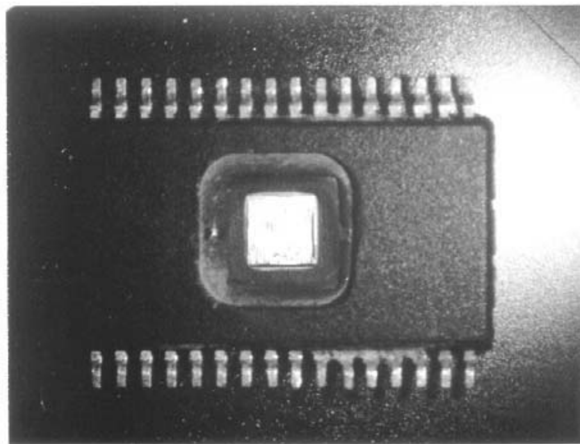
Perform selective attack using a multiple frequency laser (1064, 532 or 355nm) according to the layer.



Preparation Equipment

Back-Side polishing system

This system allows to open packaged devices in order to perform back side analysis.



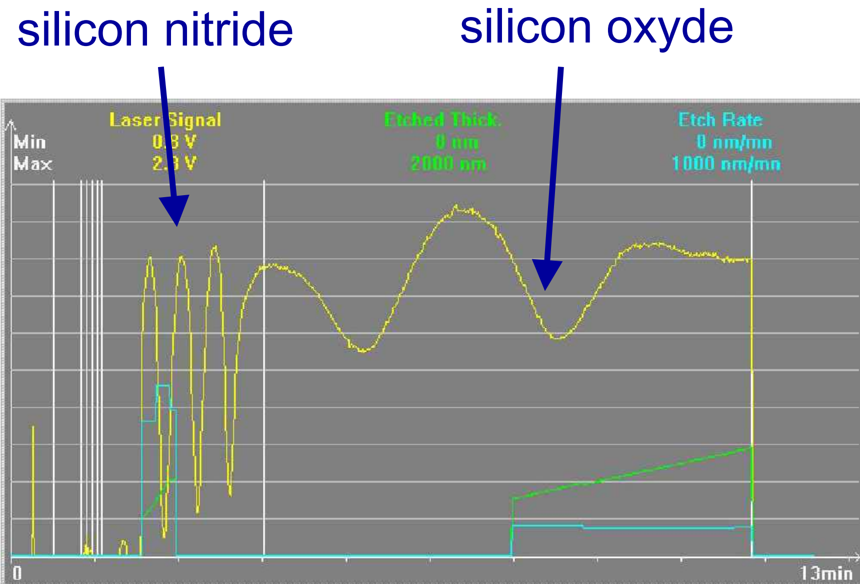
Preparation Equipment

Plasma Etcher

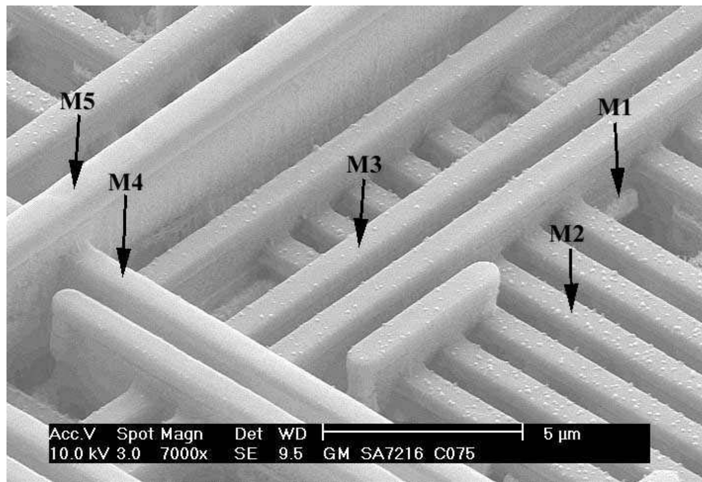
Dry etching equipment:

- used gases : O_2 - CHF_3 - C_2F_6
- RF generator
- UHF generator

This equipment allows to etch silicon nitride and silicon oxydes while preserving the electrical functionality. Classical physical deprocessing is also performed with this equipment.



Precise control of the etching is ensured by laser interferometry end point detection



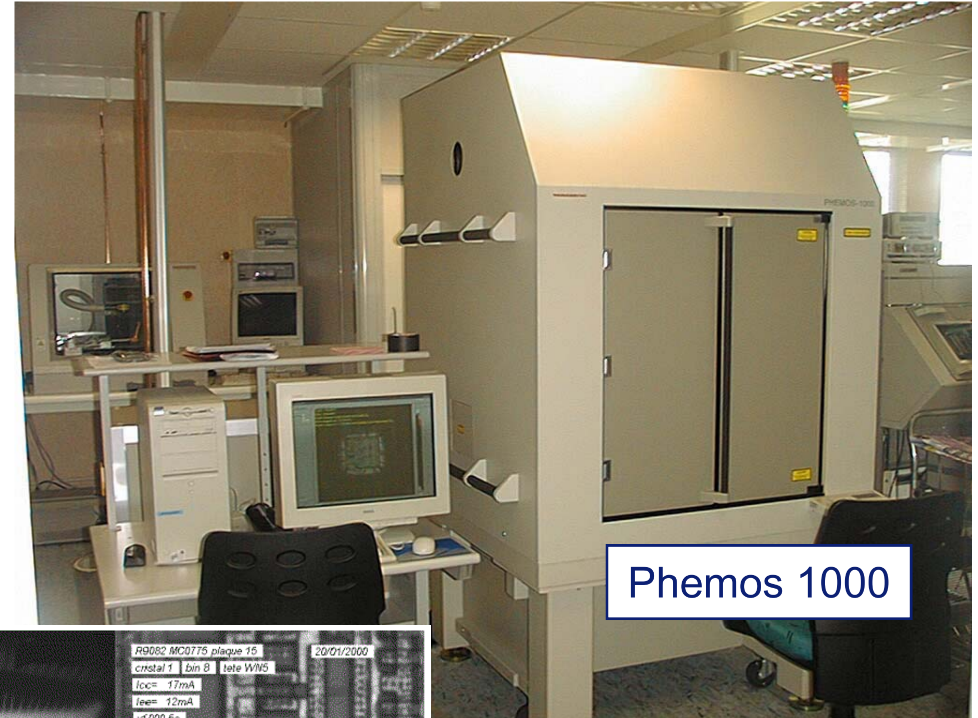
5 metal level process

Electrical Analysis Equipment

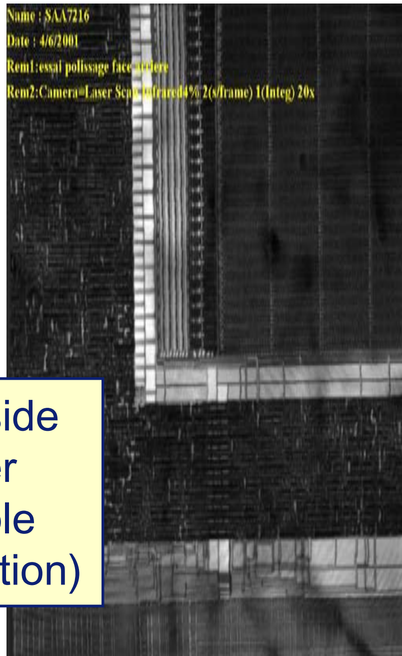
Photon Emission Microscope

Detection of faint light originating from energetic or trapped charge carriers decaying to a lower energetic state.

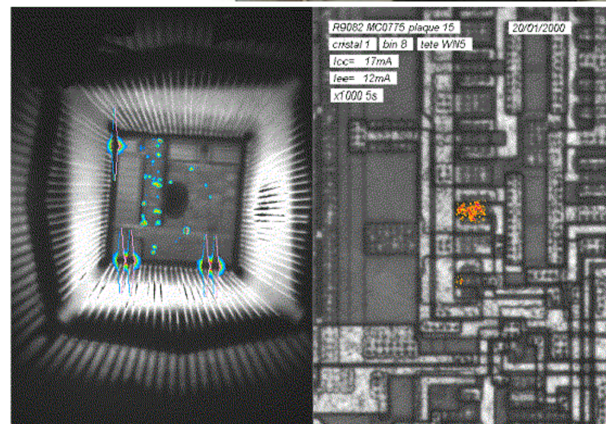
Analysis of the location of junction breakdown and current conduction through a damaged oxide.



Phemos 1000



Back side (after sample preparation)



Front side

Electrical Analysis Equipment

Liquid crystal

This equipment allow to detect leakage in ICs looking at small variation of the temperature

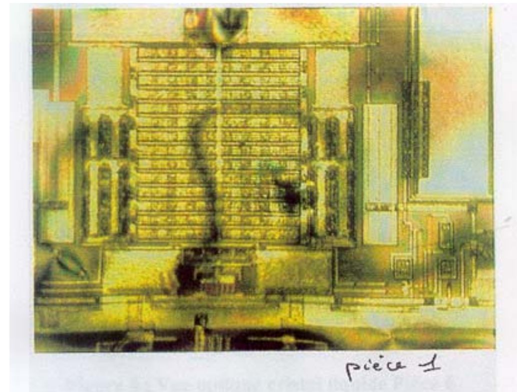


Figure 2 : Vue optique cristal liquide Pièce 1

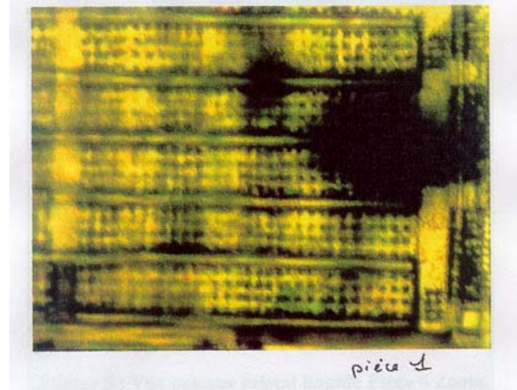
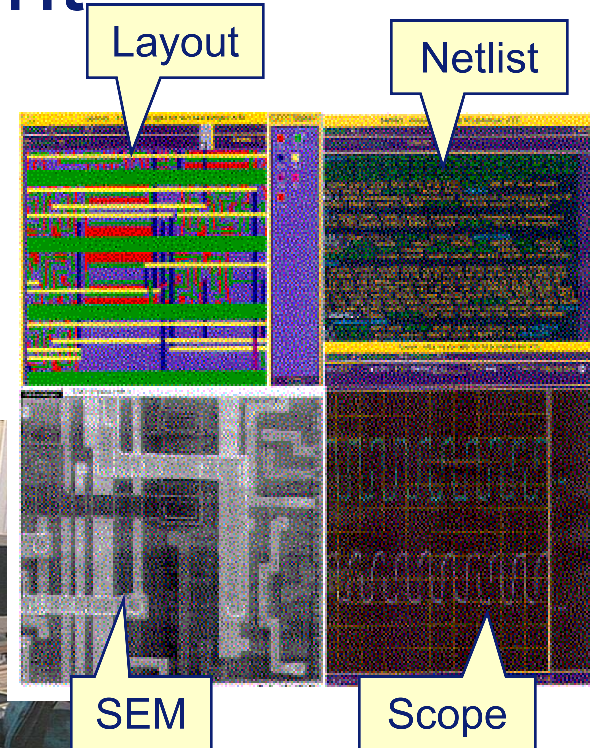


Figure 3 : Vue optique cristal liquide Pièce 1 Zoom

Electrical Analysis Equipment

Electron Beam Tester

The IDS5000 perform Fault Localisation using CAD-navigation tools coupled to an electron beam

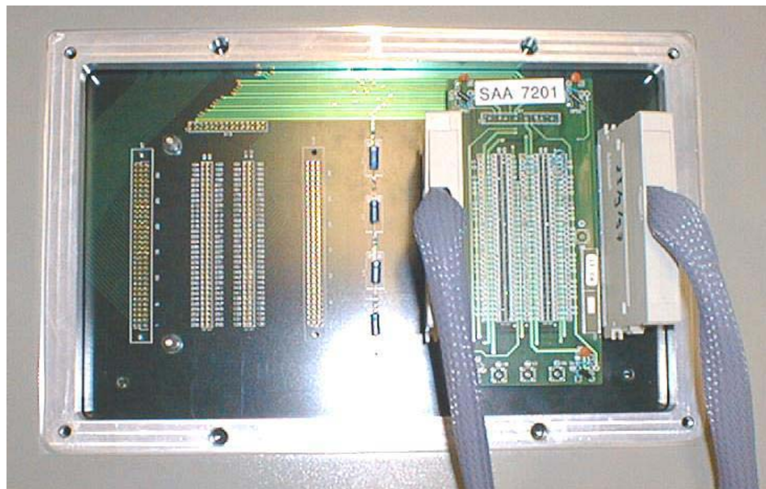


Electrical Analysis Equipment

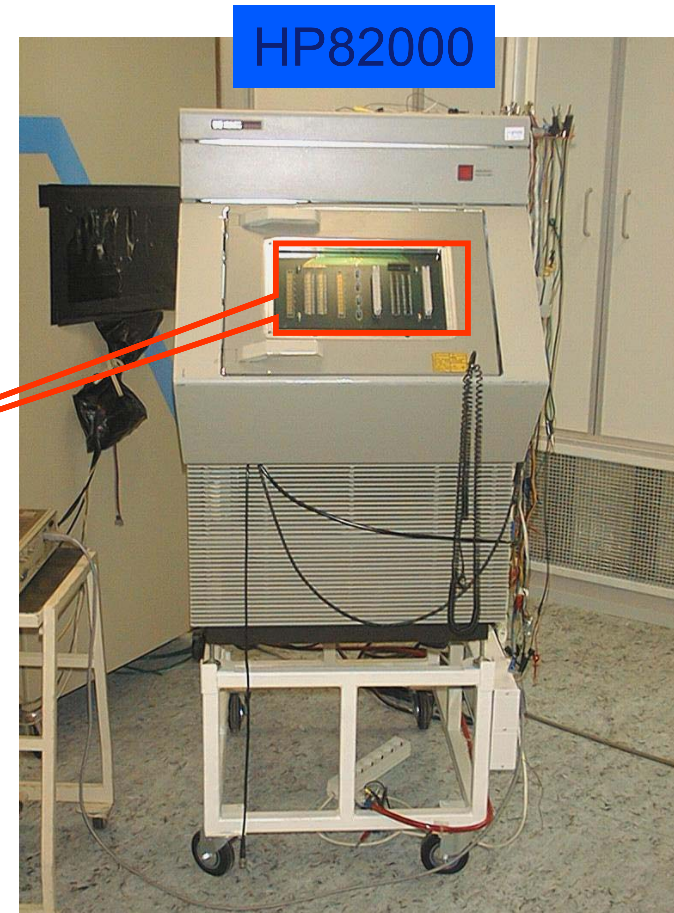
IC Tester

This Automated Test Equipment is used for digital devices. It allows to set the device in a pre-define state or to activate it

--> 120 IOs - 100MHz - 256K patterns



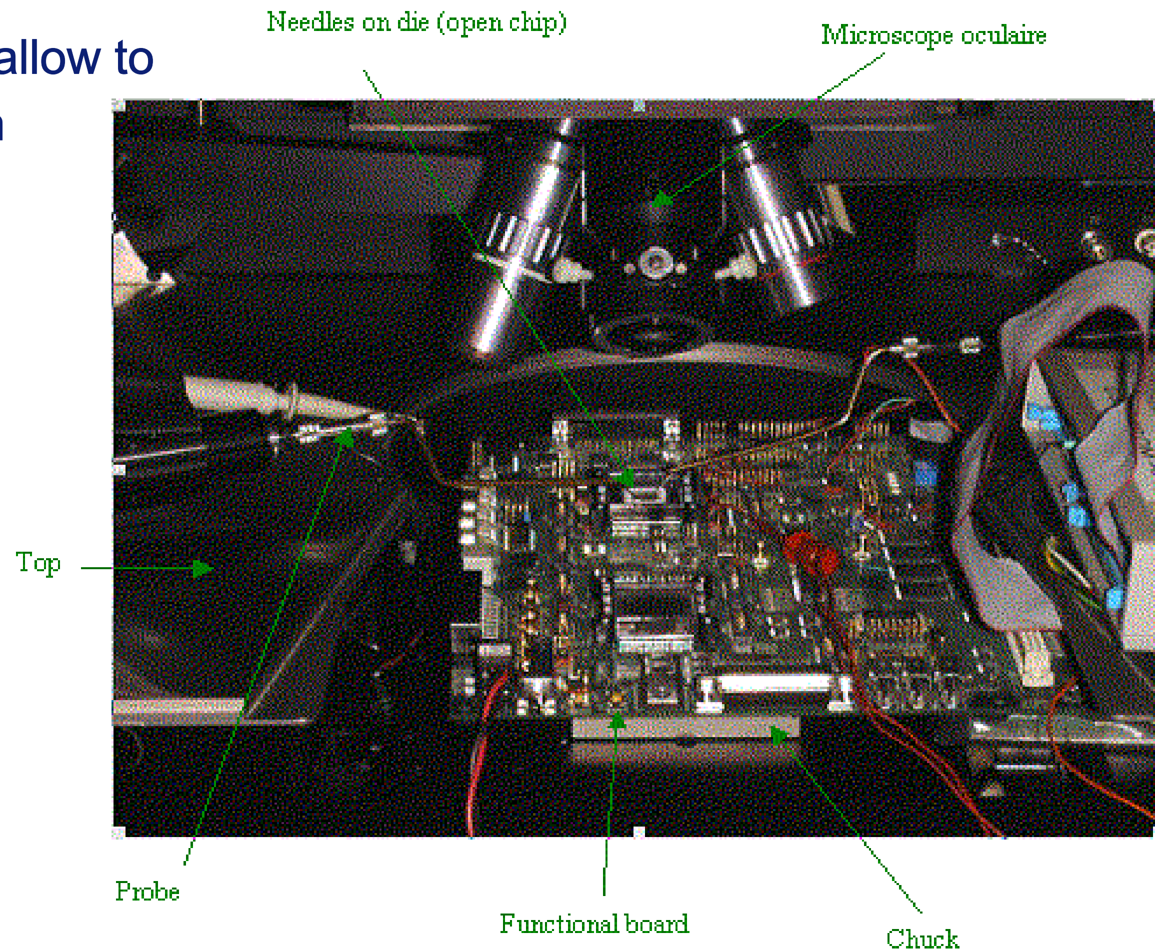
HP82000



Electrical Analysis Equipment

Micro probing Station

Probes and microscope allow to access internal nodes on de-capsulated devices.



Electrical Analysis Equipment

Magnetic Mapping experimental system

AMR and GMR magnetic sensors experimentations

Passive Integrated Components Characterization with GMR magnetic sensors

Publications : ESREF 2002 - ESREF 2003 – ISTFA 2003

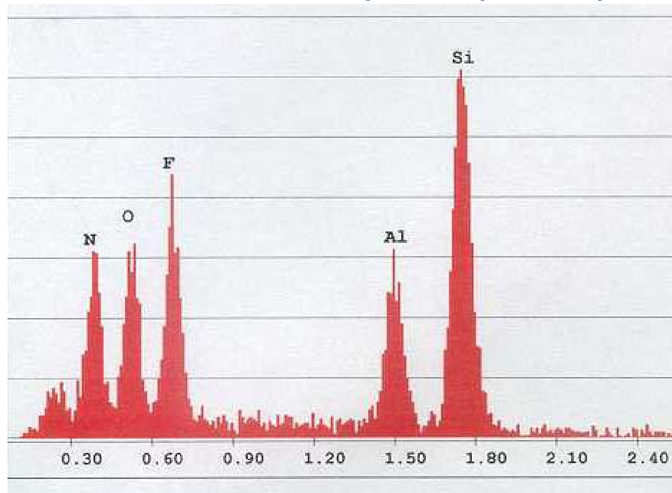
Contact : Olivier.Crepel@Philips.com

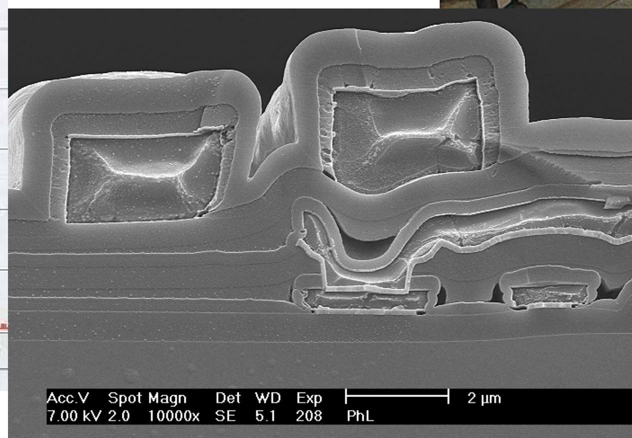
Physical Analysis Equipment

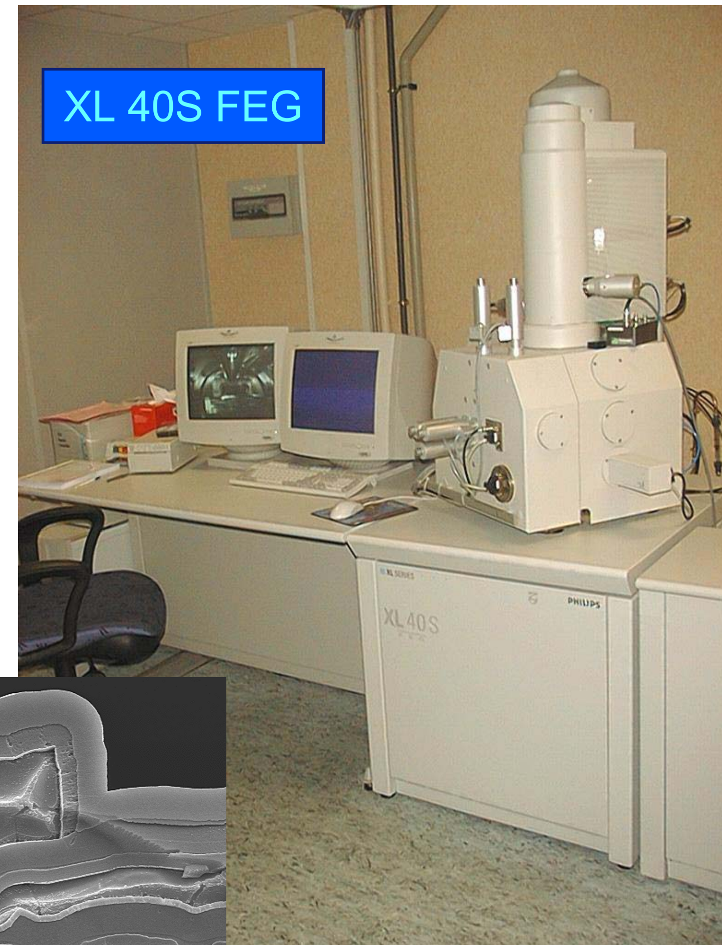
Scanning Electron Microscope

Imaging of a surface by means of a scanning focused electron beam.

Qualitative and quantitative microanalysis (EDX).



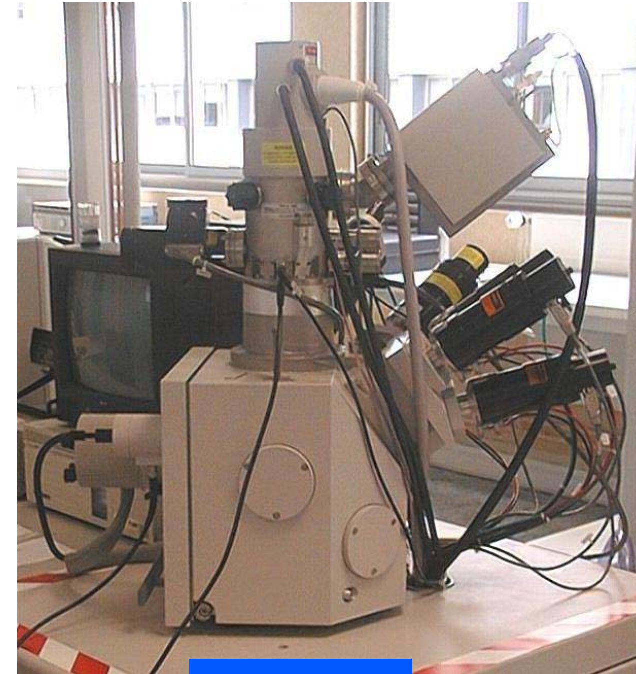




FIB applications

Focused Ion Beam

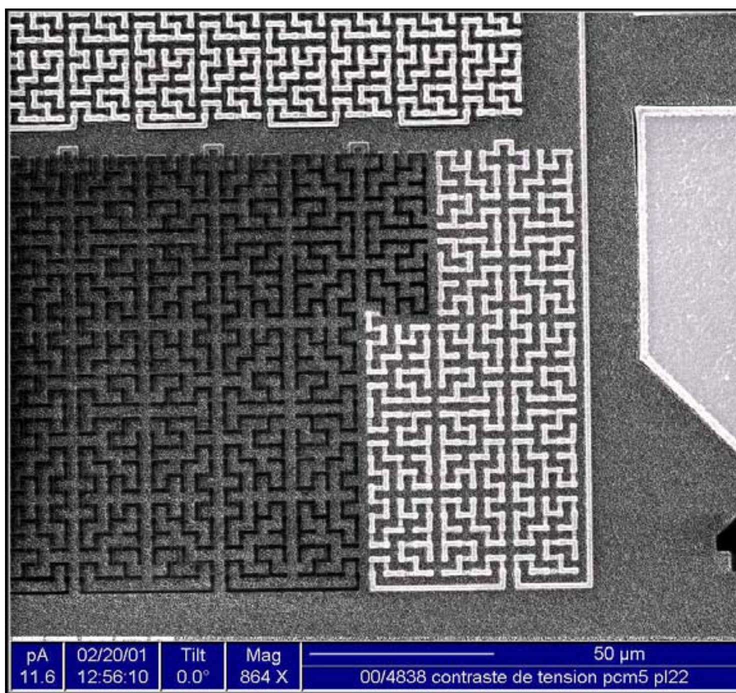
Localised deposition of conducting and/or material removal using a Ga+ ion beam.


Column

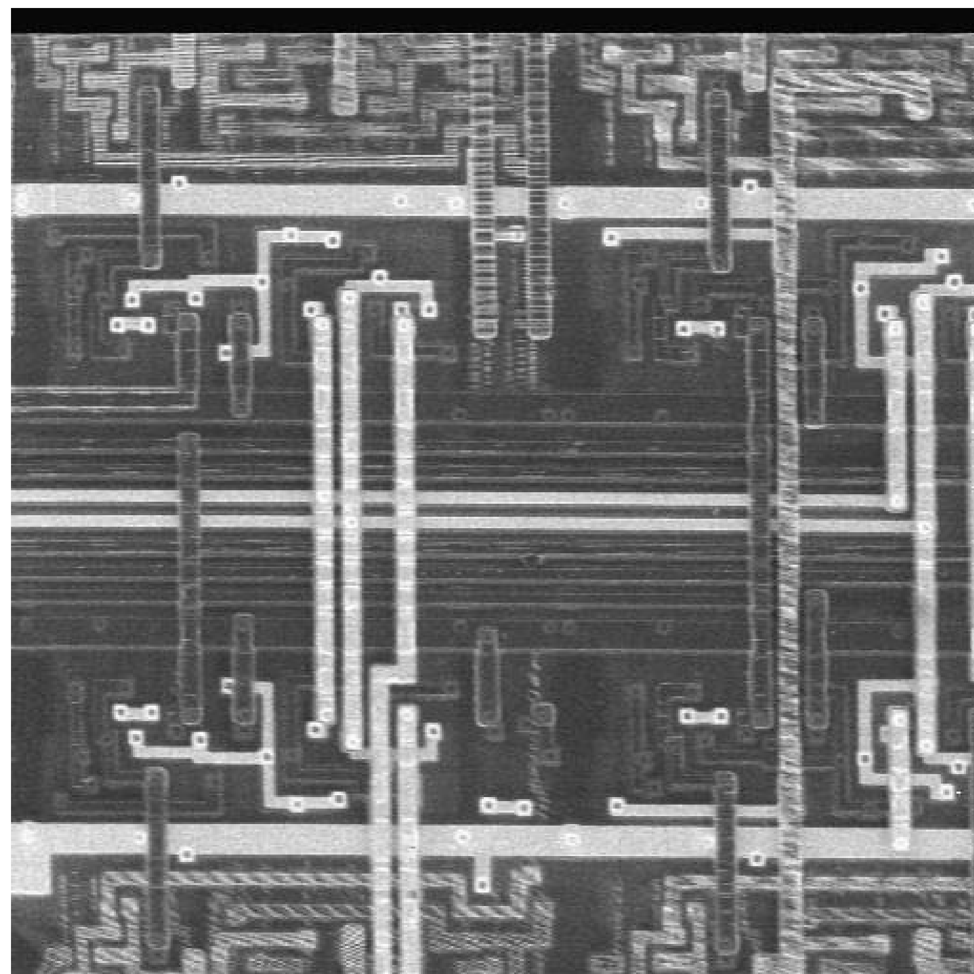
FEI 200

Voltage contrast analysis

Voltage contrast analysis could be performed using FIB, MEB or EBeam



Example 1



Example 2