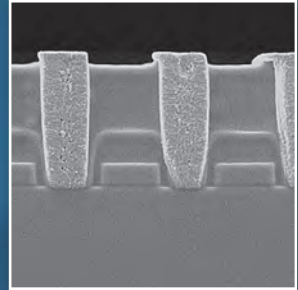
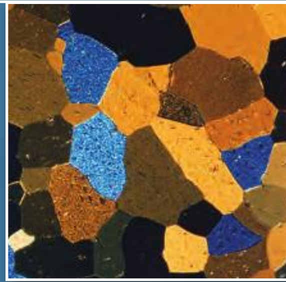
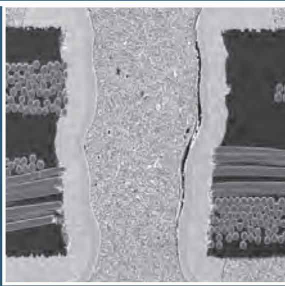
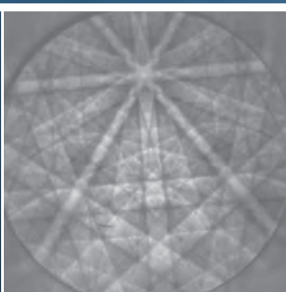






SEM Techniques Using the Gatan Precision Etching and Coating System (PECS™)



The Tool

The Technique

The Total Solution

PECS™

Precision Etching and Coating System

Not just another new tool

But a NEW

Sample Preparation

Technique

A Clean Green Technique:

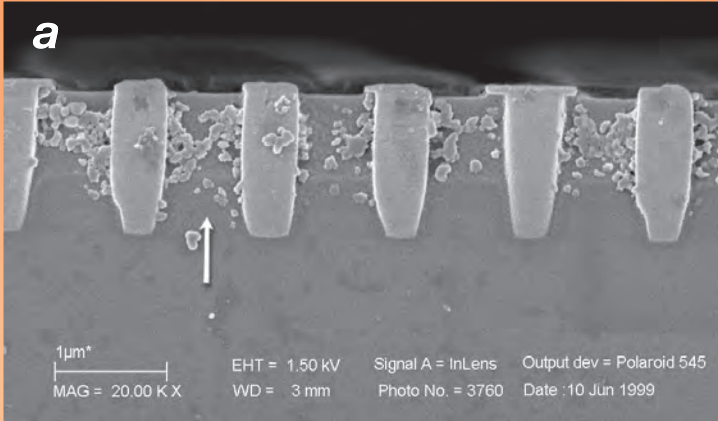
ION BEAM ETCHING

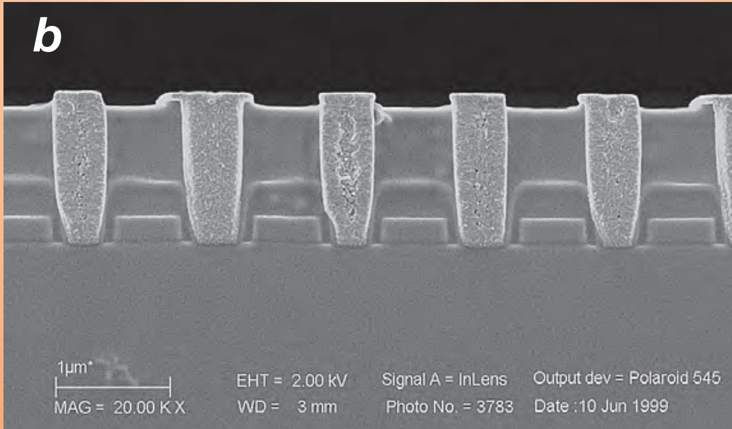
The perfect match for a FESEM or

Optical Microscope

Eliminate:
Chemical Mess
Chemical Handling
Chemical Spills
Chemical Hazards
Chemical Disposal

Cleaning

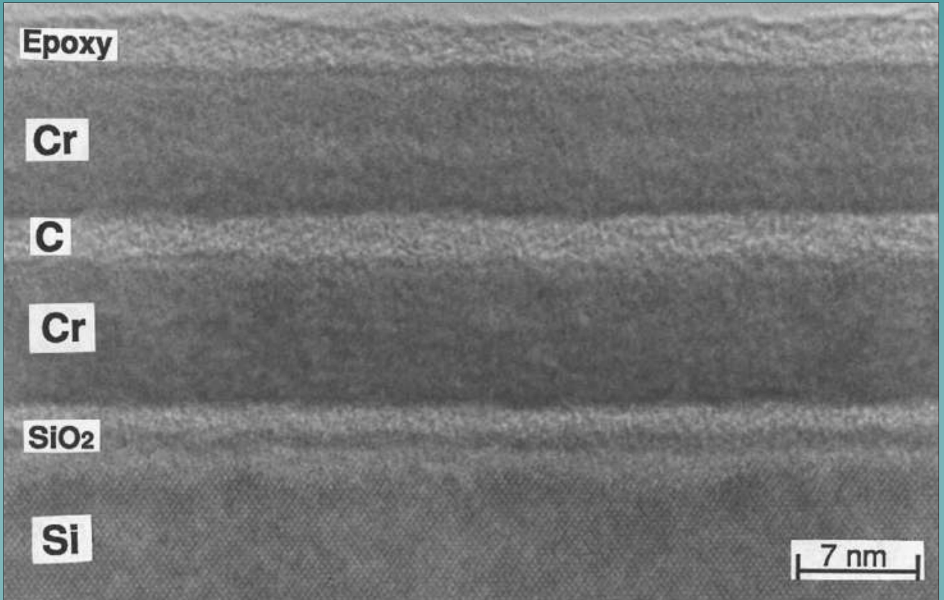




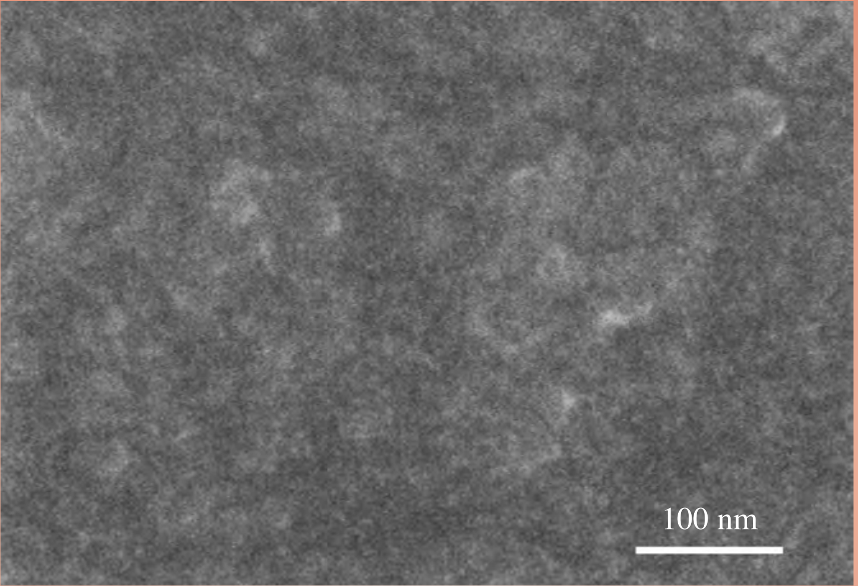
20kx

SEM images of tungsten plugs, sample was first mechanically polished. Image A shows leftover debris and contamination from polishing process (arrow). Image B is after Etch, sample is cleaned and reveals a variety of micro structural features.

Coating



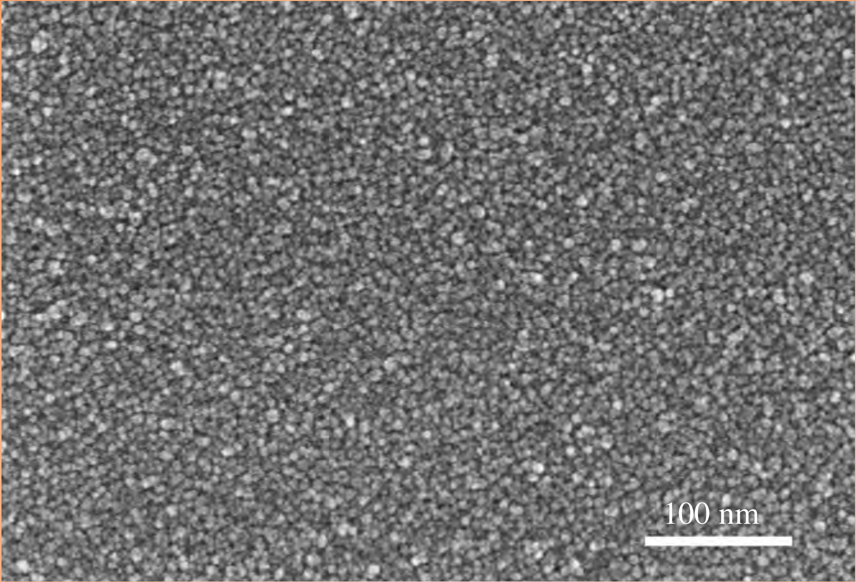
High-resolution cross-section through different coating layers of C and Cr sputtered on Si substrate.



200kx

PECS Coating

Sub-nanometer grain deposition of Chromium (Cr), thin amorphous Cr coatings can be deposited without masking delicate specimen features.

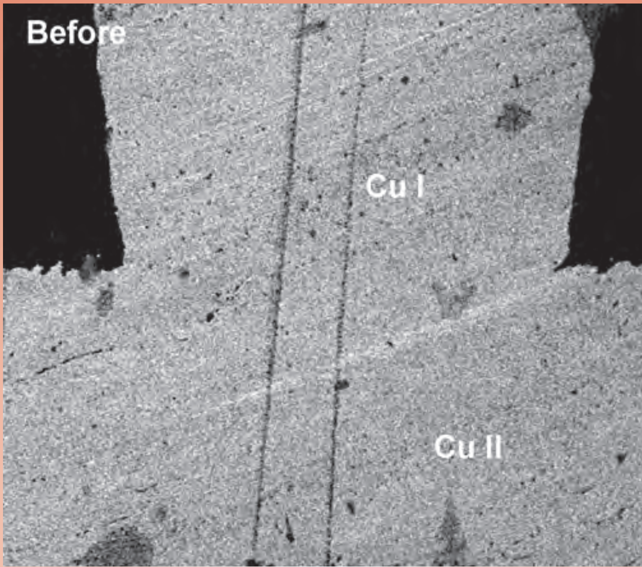


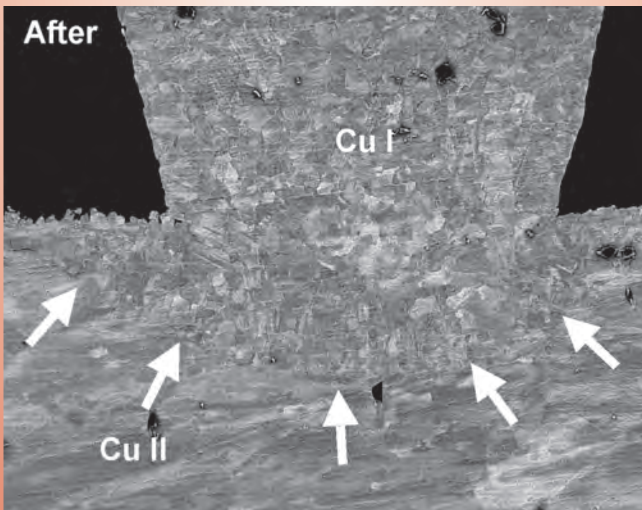
200kx

Magnetron Coating

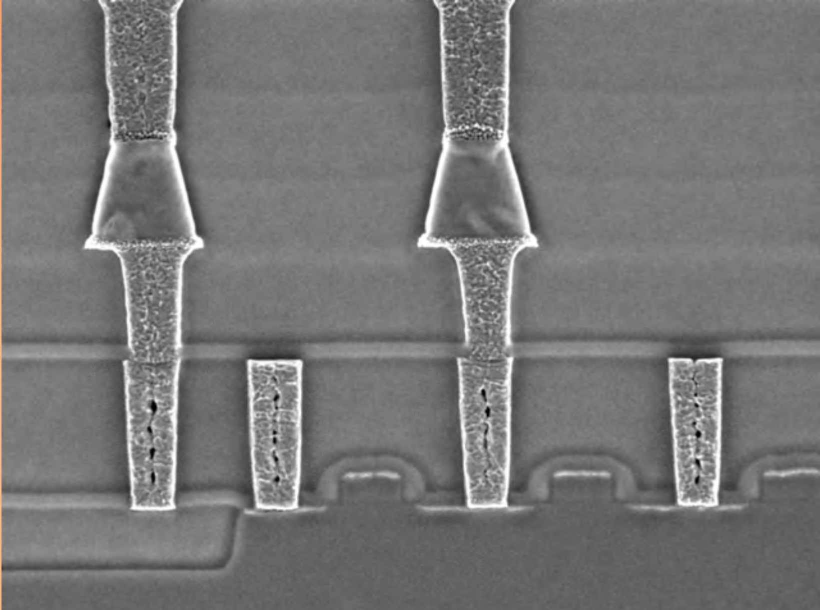
Chromium deposition by comparison is not sub-nanometer or amorphous.

Etching





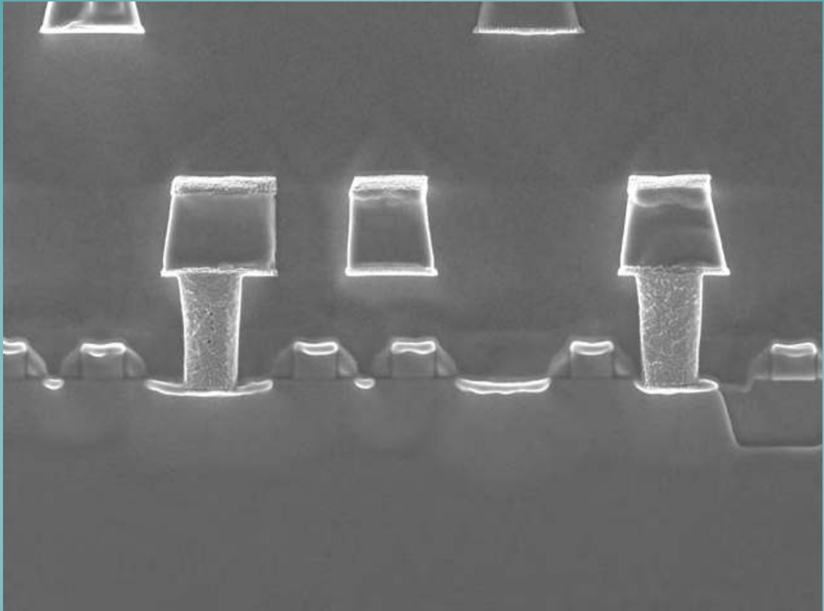
Before etch and after etch SEM images of bonded copper structures (Cu I. & Cu II). After etching shows grain size and grain morphology of each Cu structure is entirely different. Bonded interface area is also visible after etching (see arrows).



30kx

SEM image of tungsten plugs and transistors, starting sample as cleaved. Sample etched and coated.

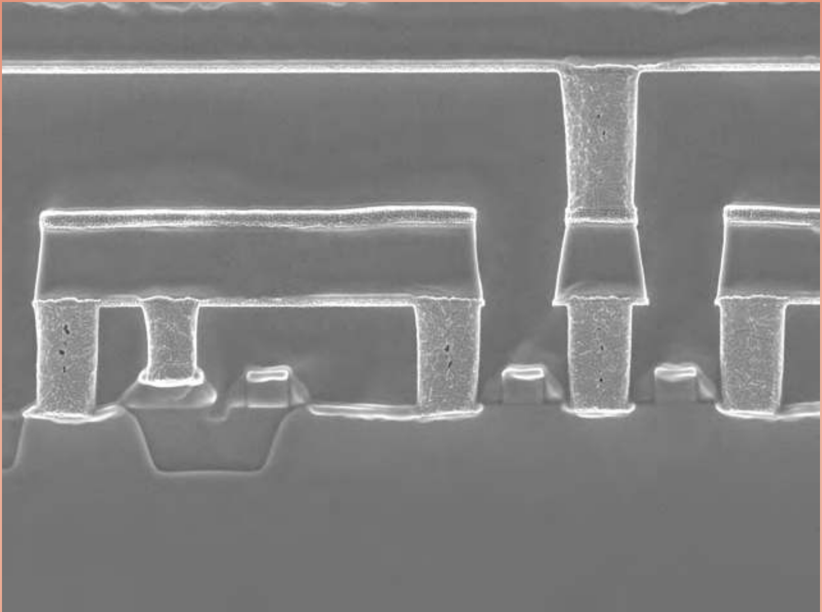
Parameter:	6 / 250 / 2 / 60° / Fix / Rotating
	6 / 250 / 1 / 0 - 30° / Rock / Rotating
Etch gas I_2	7.5 / 200 / 1.5 / 0 - 30° / Rock / Rotating
Coating Pt	6 / 200 / 0.3 / 0 - 30° / Rock / Rotating



23kx

SEM image of tungsten plugs and transistors, starting sample as cleaved. Sample etched and coated.

Parameter:	5 / 250 / 1 / 60° / Fix / Rotating
	5 / 250 / 1.5 / 0 - 45° / Rock / Rotating
Etch gas I_2	5 / 250 / 1 / 50° / Fix / Rotating
Etch gas I_2	5 / 250 / 1.5 / 0 - 45° / Rock / Rotating
Coating Pt	6 / 200 / 0.3 / 0 - 30° / Rock / Rotating

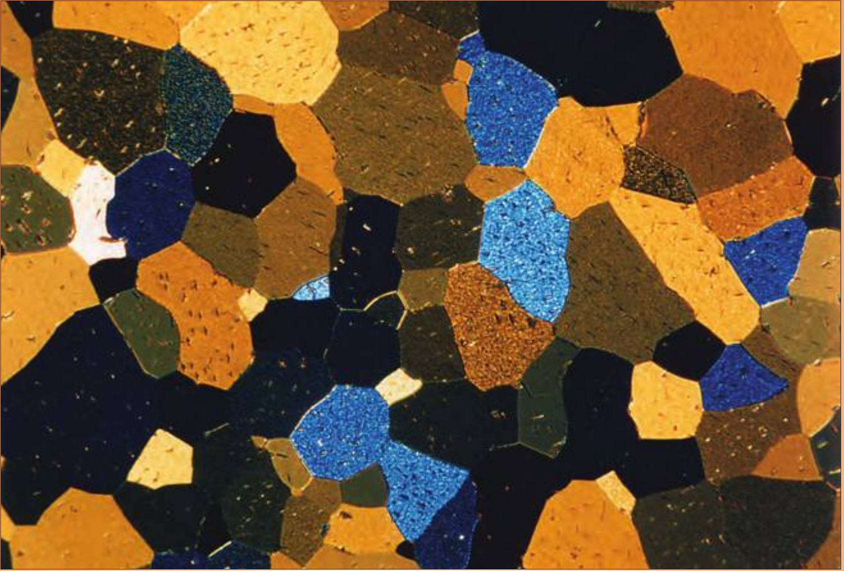


22kx

SEM image of tungsten plugs and transistors, starting sample as cleaved. Sample etched and coated.

Parameter:	5 / 250 / 1 / 60° / Fix / Rotating
	5 / 250 / 1.5 / 0 - 45° / Rock / Rotating
Etch gas I_2	5 / 250 / 1 / 50° / Fix / Rotating
Etch gas I_2	5 / 250 / 1.5 / 0 - 45° / Rock / Rotating
Coating Pt	6 / 200 / 0.3 / 0 - 30° / Rock / Rotating

Metallographic



500x

High-Purity Titanium Structure, after Etching, Micrograph with POL Filters.

Parameters: 6 / 400 / 12 / 60º / Rotating

500x

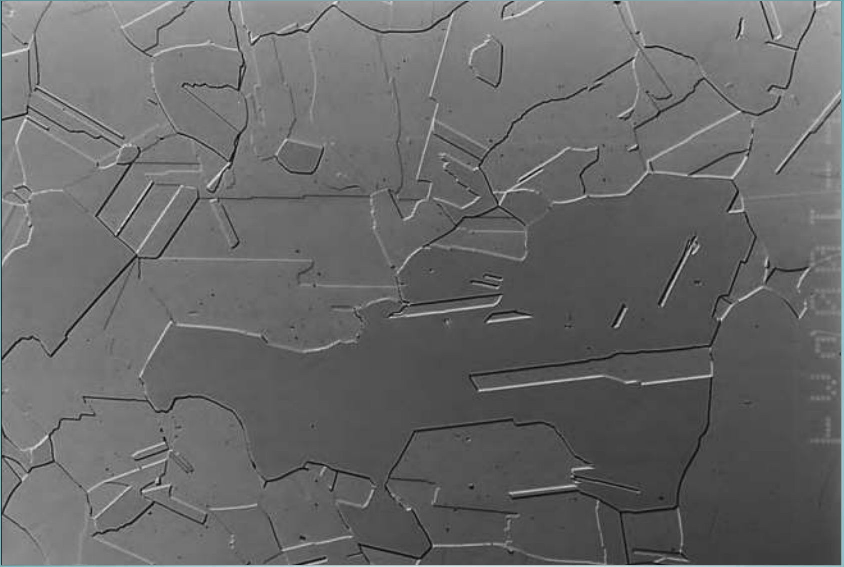
High-Purity Titanium Structure, after Etching, DIC Micrograph.

Parameters: 6 / 400 / 8 / Vertical / Rotating

200x

High-purity-Cu deformed and annealed with tin coating (< 2um)
Grain Boundaries and Twins of high-purity-Cu developed after etching, DIC Micrograph.

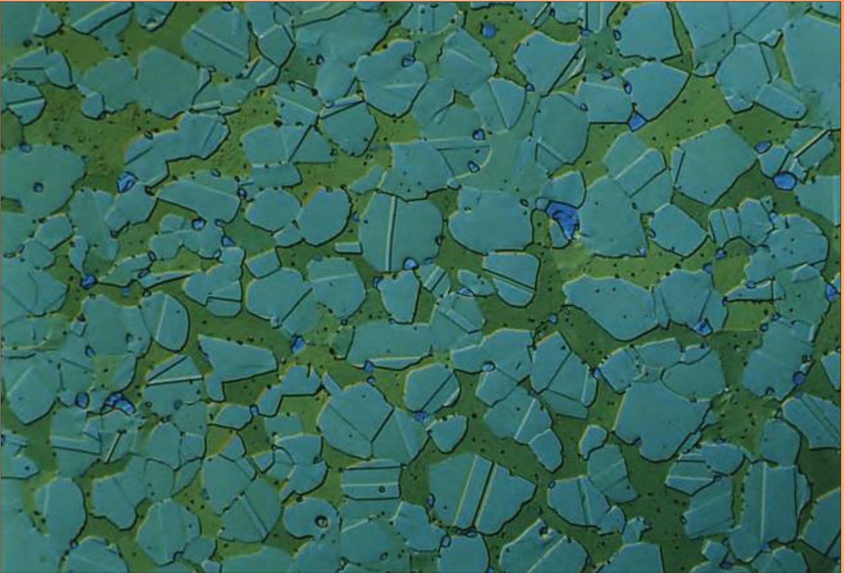
Parameter: 6 / 370 / 2.4 / Vertical / Rotating



500x

High-purity-Cu deformed and annealed with tin coating (< 2um)
Grain Boundaries and Twins of high-purity-Cu developed after etching, DIC Micrograph, Section of previous Figure.

Parameter: 6 / 370 / 2.4 / Vertical / Rotating



500x

Structure development for Machine Brass CuZn39Pb3, after etching, DIC Micrograph, Lead Droplets Retained, in part Twinning visible in Lead Droplets.

Parameter: 6 / 400 / 0.5 / 65° / Rotating plus
6 / 400 / 1.2 / Vertical / Rotating

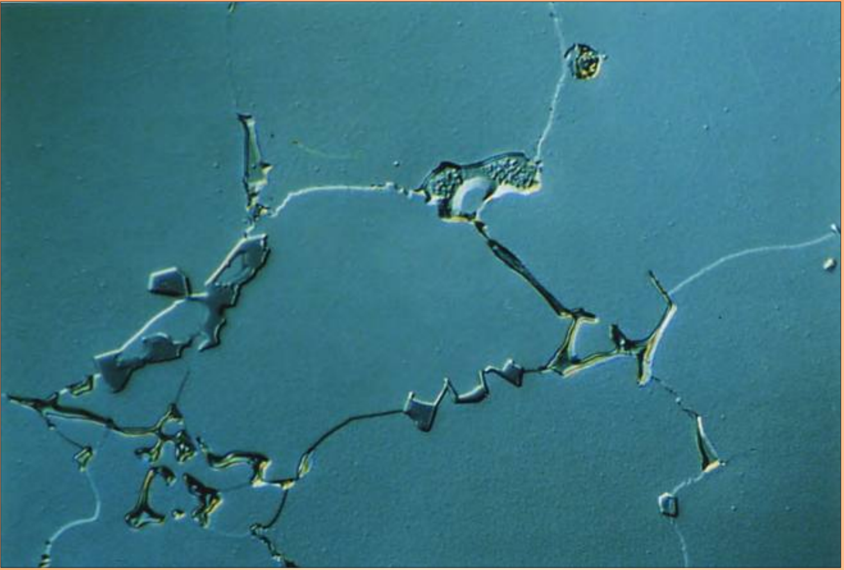
50x

Structure of High-Purity-Aluminum, after etching, POL Micrograph (rough to grainy grain surfaces appear in color).

Parameter: 6 / 400 / 12 / 53° / Rotating plus
6 / 400 / 24 / 45° / Rotating

200x

Section of previous figure, after etching, DIC Micrograph.



1000x

Structure of Al Casting AlloyAlMg4.5Mn after Etching
Micrograph with DIC, Grain Boundaries and Intermetallic Phases Etched.

Parameter: 6 / 400 / 10 / 65° / Rotating
6 / 400 / 3.4 / Vertical / Rotating
6 / 400 / 12 / 55° / Rotating

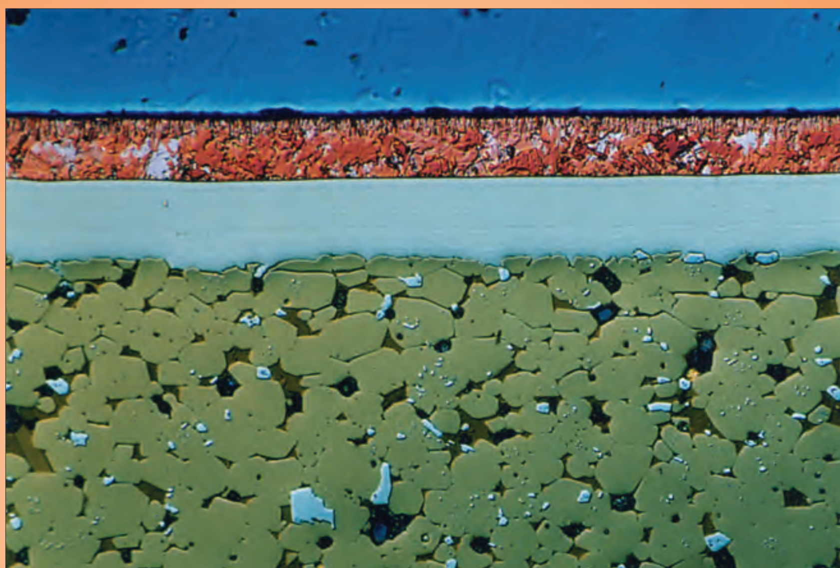
50x

Superconductor CuSn+NbTi+Ta Covered with Cu Coating, after Etching, Overview Micrograph with DIC.

Parameter: 6 / 400 / 12 / 45° / Rotating
6 / 400 / 2.4 / Vertical / Rotating
6 / 400 / 2 / 10° / Rotating

100x

Superconductor CuSn+NbTi+Ta Covered with Cu Coating, after Etching, Lower Area of previous Figure, CuSn Matrix with NbTi fibers, Micrograph with DIC.

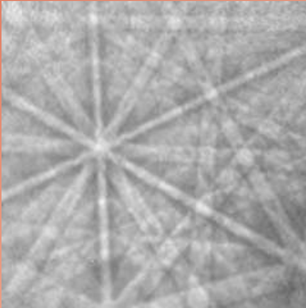


500x

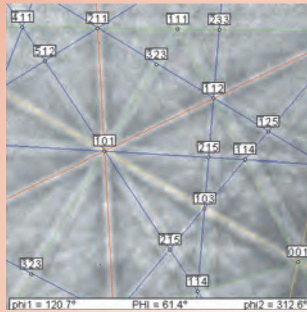
Structure from the Edge of Permanent Magnet FeNdB(1%) with protective layers of Cu and Ni, after Etching, Micrograph with DIC, improved contrast of tarnished layer by means of additional O_2 etching

Parameter:	6.5 / 480 / 5 / 40° / Rotating
	6.5 / 510 / 7 / 10° / Rotating
Etch gas O_2	8 / 450 / 4 / Vertical / Rotating

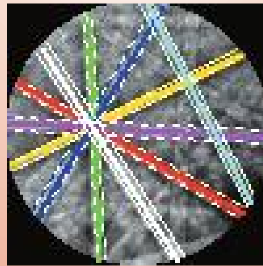
EBSD



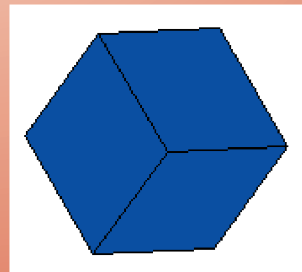
EBSP



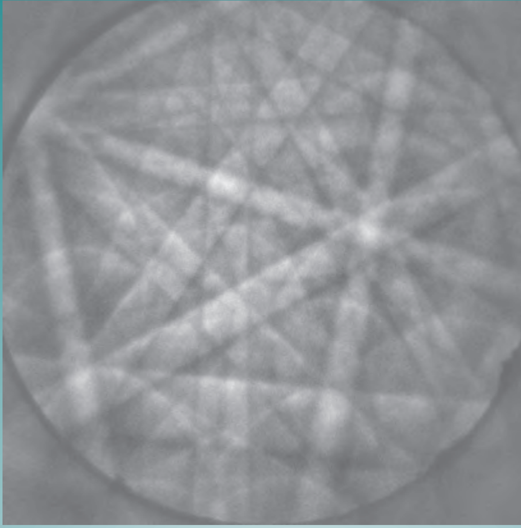
Indexed Pattern



Detected Bands

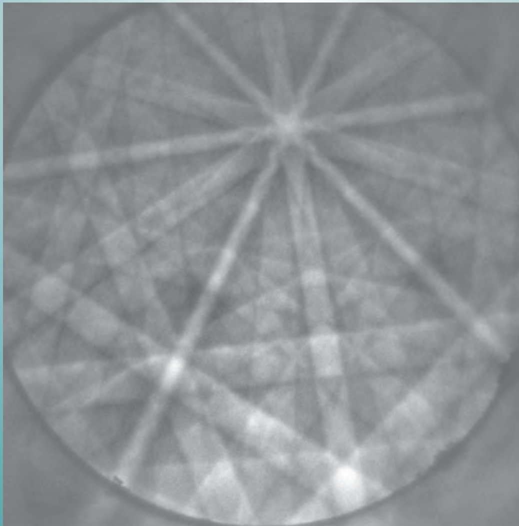


Crystallographic Orientation



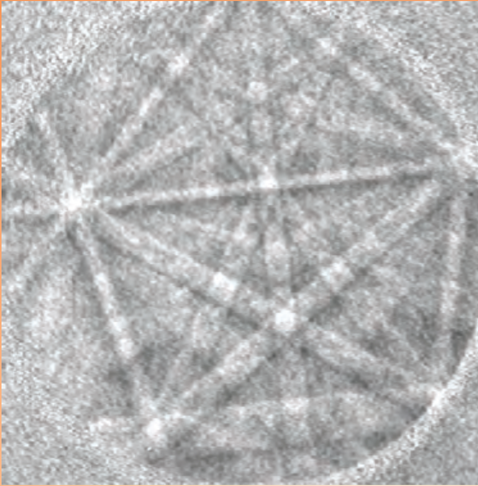
Cu sample, Image Quality = 193 Votes = 35, 15 keV SEM acceleration voltage.

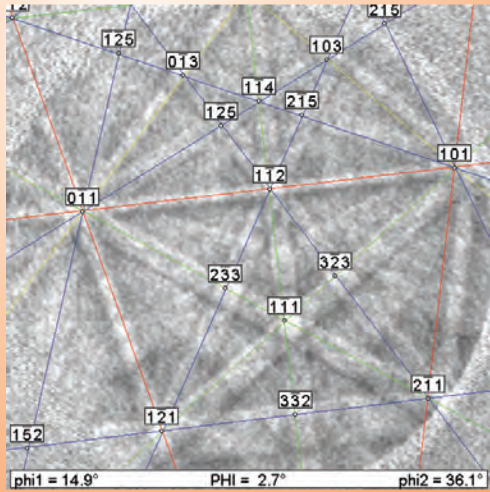
Parameters: 7.5 / 175 / 240 / 70°/ Rotating



Cu sample, Image Quality = 204 Votes = 35, 30 keV SEM acceleration voltage.

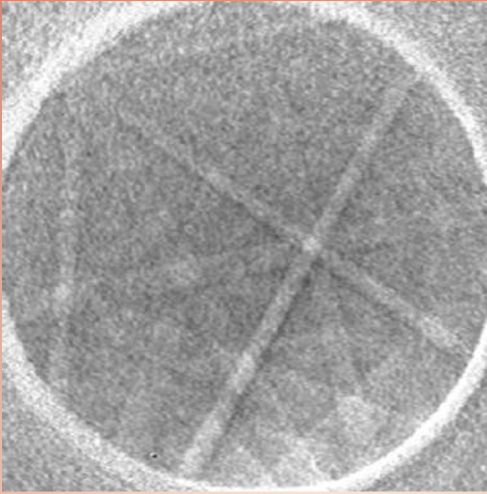
Parameters: 7.5 / 175 / 240 / 70°/ Rotating

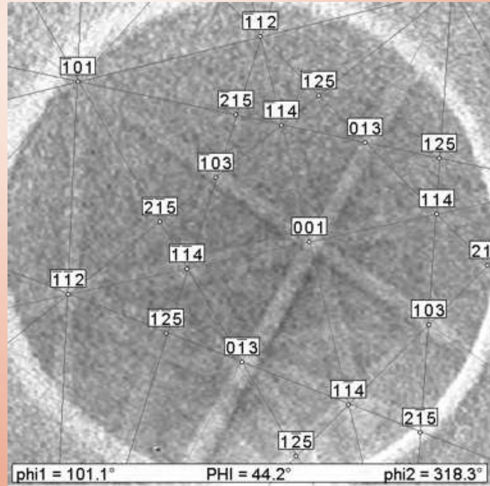




Cu film, Image Quality = 228, 25 keV SEM acceleration voltage, spot size 4.

Parameters: 2.5 / 60 / 115 / 50°/ Rotating

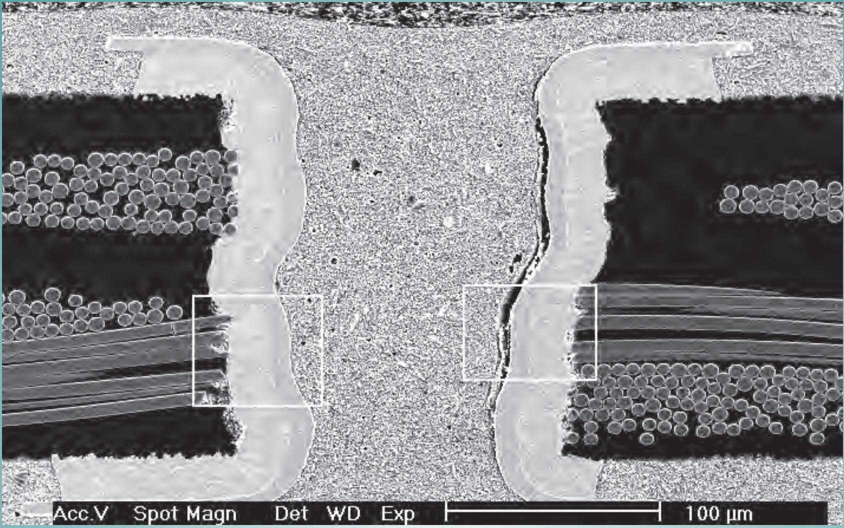




Aluminum film, Image Quality = 114, 25 keV SEM acceleration voltage, spot size 4.

Parameters: 2.5 / 60 / 30 / 50°/ Rotating

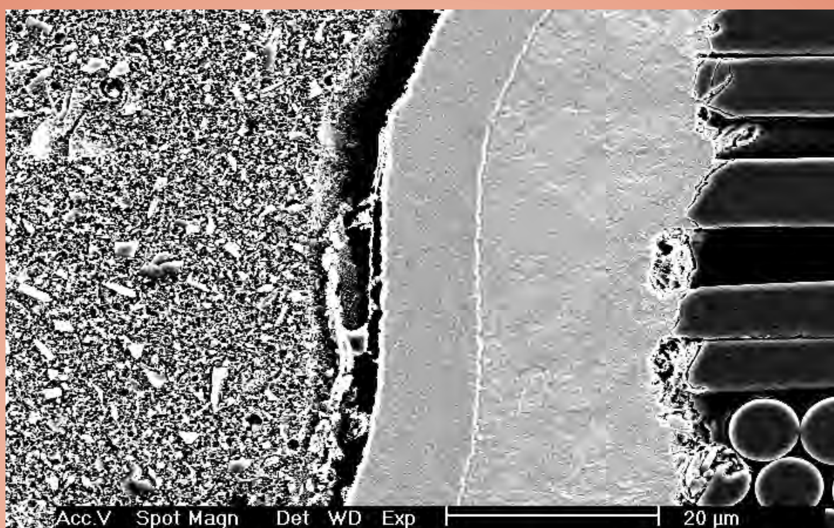
DIE Package



300x

Die Package, after Ar etch, overall view of Via hole,
Delamination between solder resist and via hole inner wall.
Metal grain structure not visible at all before etch.
See following pages for indicated areas.

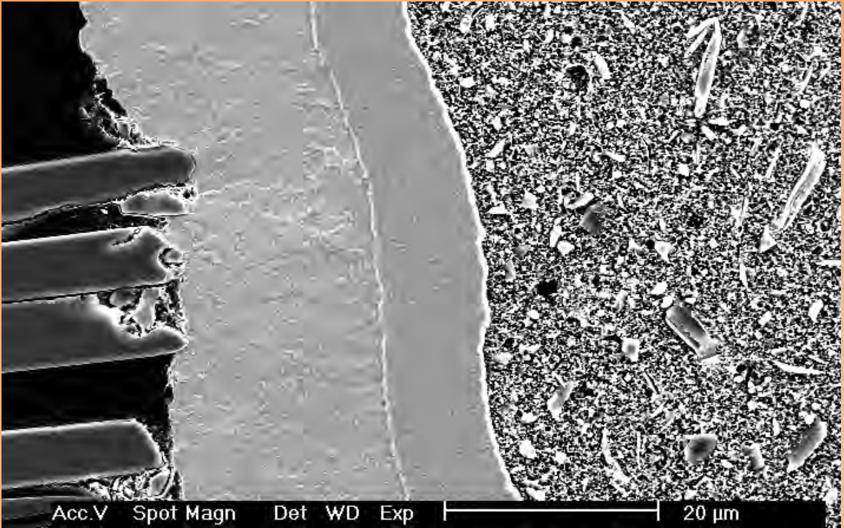
Parameter:	7 / 200 / 3 / 50° / Fix / Rotating
	5 / 200 / 5 / 0 - 30° / Rock / Rotating
Etch gas I_2	5 / 200 / 5 / 0 - 30° / Rock / Rotating
	6 / 200 / 0.5 / 0 - 30° / Rock / Rotating



1500x

Die Package, after Ar etch, enlarged view from Right side of Via hole, Delamination between solder resist and via hole inner wall. No grain structure visible before etch.

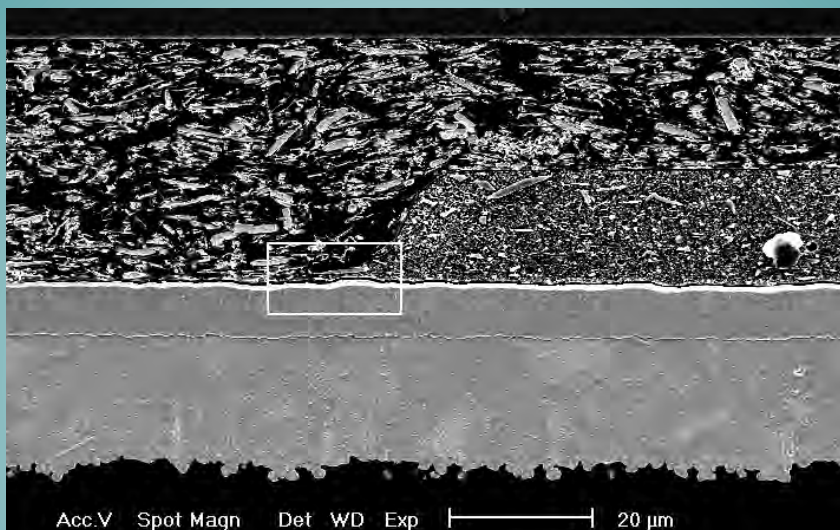
Parameter:	7 / 200 / 3 / 50° / Fix / Rotating
	5 / 200 / 5 / 0 - 30° / Rock / Rotating
Etch gas I_2	5 / 200 / 5 / 0 - 30° / Rock / Rotating
	6 / 200 / 0.5 / 0 - 30° / Rock / Rotating



1500x

Die Package, after Ar etch, enlarged view from Left side of Via hole, No delamination. No grain structure visible before etch.

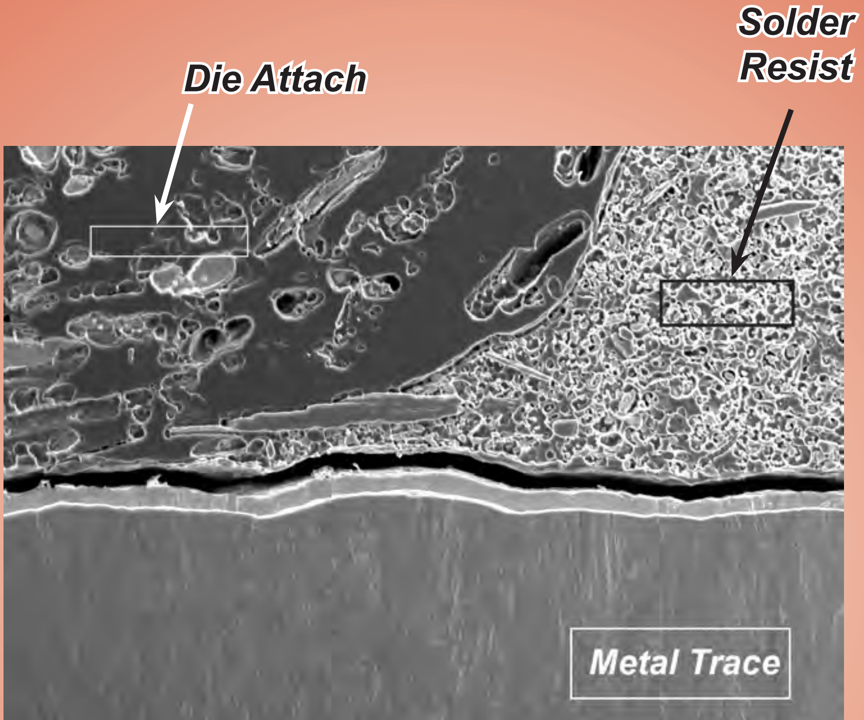
Parameter:	7 / 200 / 3 / 50° / Fix / Rotating
	5 / 200 / 5 / 0 - 30° / Rock / Rotating
Etch gas I_2	5 / 200 / 5 / 0 - 30° / Rock / Rotating
	6 / 200 / 0.5 / 0 - 30° / Rock / Rotating



1000x

Die Package, after Ar etch, Overall view of Die attach and Solder resist with delamination between Metal trace of Cu and 0.5um Ag. No grain structure visible before etch. See enlarged area on next page.

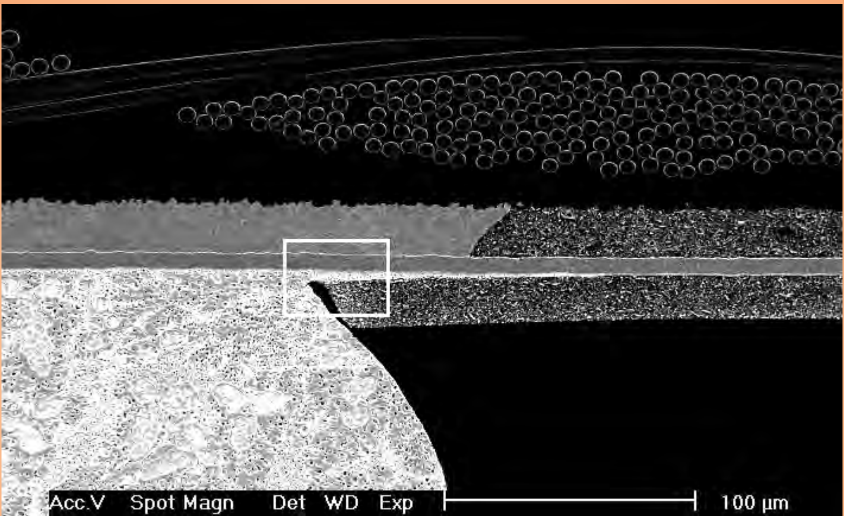
Parameter: 7 / 200 / 3 / 50° / Fix / Rotating
5 / 200 / 5 / 0 - 30° / Rock / Rotating
6 / 200 / 0.5 / 0 - 30° / Rock / Rotating



5000x

Die Package, after Ar etch, enlarged view from previous page, Die attach and Solder resist with delamination between Metal trace of Cu and 0.5um Ag.

Parameter: 7 / 200 / 3 / 50° / Fix / Rotating
5 / 200 / 5 / 0 - 30° / Rock / Rotating
6 / 200 / 0.5 / 0 - 30° / Rock / Rotating



350x

Die Package, after Ar etch, Overall view of Die attach, Solder resist and Metal trace of Pb, Cu and 6um Ag.

Parameter: 7 / 200 / 3 / 50° / Fix / Rotating
5 / 200 / 5 / 0 - 30° / Rock / Rotating
6 / 200 / 0.5 / 0 - 30° / Rock / Rotating

2000x

Die Package, after Ar etch, Enlarged view of Die attach, Solder resist and Metal trace of Pb, Cu and 6um Ag.

Parameter: 7 / 200 / 3 / 50° / Fix / Rotating
5 / 200 / 5 / 0 - 30° / Rock / Rotating
6 / 200 / 0.5 / 0 - 30° / Rock / Rotating