EBSD – Electron Backscattered Diffraction
Nooshin Mortazavi

Acknowledgement:
Dr. Patrick Camus

Why we need Electron Backscattered Diffraction (EBSD)?

Crystallographic orientation
Isn't the anisotropy of the individual crystals averaged out in the bulk?

Case study- orientation of the grains in an alumina CVD coating

Example 2

Aluminum Example

An image or pattern quality map can often reveal more structure than an SE image
Orientations can also be represented by color or by crystal.

This makes grain size analysis simple and fast. This data was collected in less than 2 minutes.

Is there any relationship between oxidation and Orientation of the grains in pure Cr?

After putting the sample for 2 min at 950°C, is there any preferential oxidation growth?

On which grain we have more oxidation?

1) D
2) B
3) C
4) Random oxidation growth
For pure Cr, more growth of oxide layer on the grains with the orientation of 111.

EBSD basics

How does it work?

Talk Outline

• What is EBSD
• How does it work?
• Why and where we use EBSD technique
• Summary
EBSD is:

• Abbreviation for Electron Backscattered Diffraction technique.

• A Scanning Electron Microscope (SEM) based technique

• Can be used to analyse any crystalline material

What can EBSD tell us?

• EBSD provides 3 main types of information:
  • The 3D orientation of the crystal lattice
  • Identifies different phases
  • Identification of unknown phases when used in conjunction with EDS
Fundamentals

- EBSD: Electron Backscatter Diffraction

Introduction to Diffraction

Bragg’s Law: \( n \lambda = 2 d \sin \theta \)

Kikuchi pattern formation
Indexing cycle

Place beam → Collect pattern → Detect bands

Phase and orientation determined → Match found → Look for match with simulated patterns

Mapping

Polycrystalline Sample

Alignment of Crystallites, Inverse Pole Figure
What other information can we obtain from EBSD?

Typical measurements
- Phase distribution
- Phase identification
- Texture (preferred orientations)
- Grain size
- Boundary properties (e.g., twin boundary frequency)
- Strain fields
- Misorientation data
- Recrystallised / deformed fraction
- Intra-granular deformation
- Plus much, much more
A typical "phase map" from an automated EBSD analysis (192,324 measurements) of a Ti-alloy, showing the alpha (hcp) and beta (cubic) phases.

**Summary**

- **EBSD**: Electron Backscatter Diffraction
- Automated collection & indexing of electron diffraction (Kikuchi) patterns from bulk samples in the SEM
- General microstructural characterization technique
- Near-surface analysis
  - Shallow: Tens of nm from surface
  - Surface
- Materials analyzed
  - Almost anything crystalline that survives under the beam
  - Metals, ceramics, minerals
  - Conductors and insulators

**Notes**

- Pole piece
- Detector (camera)
- Screen

**Materials**

- Ceramic
- Metal