UNIVERSITY of MISKOLC
Faculty of Materials Science and Engineering

Antal Kerpely Doctoral School of Materials Science & Technology

X-ray diffraction methods

Dr. Valéria Mertinger

COURSE DESCRIPTION

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Author: Dr. Valéria Mertinger

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Dr. Valéria Mertinger

Lecturer

Dr. Valéria Mertinger, professor, Institute of Physical Metallurgy, Metalforming and Nanotechnology.

room: B1 gr fl. 3 mail: femvali@uni-miskolc.hu, tel: 1545, 302183699,
http://www.matsci.uni-miskolc.hu/mertinger.htm

Recommendation

The lecture is propoesd for all students of the Kerpely doctral school, especially in the field of metalforming, physical metallurgy, heat treatment and casting.

Language

Hungarian or English.

Scope

The objective of the course is to teach the parts and operation of an X-ray diffractometer, its main application methods.

Methodology

For larger student numbers, the course is held in contact lectures. The time of contact courses is based on agreements with the students. In case of 1-2 students, keywords are given of the corresponding block. Three blocks in total cover the whole course. Basic questions are also given for the blocks. 3 meetings are held during which answers for the basic questions, the students' questions and fundamentals are discussed.

Topics

1.Topic

Structure of an X-ray diffractometer

The Bruker d8 diffractometer is inspected. A sketch is requested to make of its main parts.
Electron beam-matter reactions
X-ray beam-matter reactions
Diffraction, structure factor

Basic questions:

1. *Expound the processes within an X-ray tube.*
2. *How are Fe Kα1, CoKβ radiations produced?*
3. *Why must the X-ray tube be cooled?*
4. *What is the role and fundamental operation of the absorption filters?*
5. *What function type absorbs the different wavelength copper radiations?*
6. *What is the result of X-ray photons scattered with a path difference on atoms being in distance s?*
7. *What happens if the wavelength, or its integer multiple of an X-ray beam, diffracted on a plane series with plane distance d equals the multiplication of two*

times d and the sin of the angle between the primary beam and the diffracting plane?

8. *What is the reciprocal lattice?*
9. *On what does the formation of the diffraction cone in the reciprocal lattice depend?*
10. *What superposition types are possible of of two diffracted photons with the same wvelength and different phases?*
11. *Do we get reflection (diffraction maximum) from the (110) plane series of austenitic steel in case of Co tube? And if Cr tube is applied?*
12. *What is the structure factor?*
13. *Do we get reflection (diffraction maximum) from the (111) plane series of steel in case of Co tube? And from the (220)? Why?*

2.Topic

Detecting the X-ray beam
Properties of the interference function, diffractogramm
Qualitative phase analysis
quantitative phase analysis

Basic questions:

1. *Does the detector moving on the goniometer circle measure all possible diffraction maximums?*
2. *Characterise one diffractogramm.*
3. *What data describe the diffraction profile obtained from the (200) plane series of steel?*
4. *What type of fixed tool is able to find all possible diffraction maxima?*
5. *Select a material of your choice, find all information about it in the PDF2 database.*
6. *Interference functions of steel (110) and (200) will probably differ. Why?*
7. *What problem arises during the ferrite content determination of cold rolled steel sheet?*
8. *What is the general problem during the absorption factor calculation?*
9. *You have to determine the retained austenite fraction in ball bearing steel. What do you measure? What can be identified using X-ray diffraction? eleemnts or phases? What kind?*
10. *Which factors must be dealt with during quantitative phase analysis?*
11. *Why can the absorption factor be neglected during retained austenite fraction determination in quenched steel?*
12. *Does the location of sampling have an effect during quantitative phase analysis in case of cast or cold rolled materials?*
13. *Which property of the reflection of a (hkl) plane series correspond to quantitative phase analysis?*

3.Topic

Residual stress measurement
Texture measurement
Profile analysis

Basic questions:

1. *residual stress is to be measured in the valley of a gear wheel. Which property of the interference function is changed due to the resident stress?*
2. *What do you measure and how?*
3. *What special feature is required for texture (ODF) measurement compared to phase analysis?*

4. *How many reflections are measured during inverse pole figure measurement and which property is to be measured?*
5. *How can the dislocation density be determined in rolled sheet using X-ray diffraction?*
6. *residual stress is to be measured on the surface of ball bearing ring, how do you carry put the measurement?*
7. *How do you know, that compressive or tensile stress is measured?*
8. *What do we mean by texture and what is its consequence?*
9. *What is the most complete mode to describe texture?*
10. *which property of the interference function is changed by lattice defects?*

References

1. Aaron D.Krawitz:Introduction to Diffraction in materials Science and Engineering, John Wiley & Sons , 2001
2. H.Klug, L. Alexander: X ray diffraction procedures, Wiley & Sons , 1974
3. Dr Bárczy Pál, Dr Fuchs Erik, Metallográfia I. Tankönyvkiadó, 1981
4. + In case the student applies the method during his/her research, special literature is provided to the specified field.

Exam

Oral exam if basic questions are answered correctly.

Complex exam questions

1. The role of X-ray diffraction techniques in fine structure analysis. Benefits, disadvantages, limits.
2. The practical applications and limits of X-ray diffraction qualitative and quantitative analysis.
3. X-ray diffraction anisotropy examinations, information content and application areas of the different methods.
4. The role, importance and X-ray diffraction measurement method of residual stress.
5. Profile analysis and application fields in material science.