Training Course

X-ray techniques for materials development and process control

Non-destructive insights for advanced materials and processes

22 - 24 Sep 2025
online

Training Chair

Prof. Dr. Ehrenfried Zschech
Brandenburg University of Technology (BTU)
Cottbus-Senftenberg

DGM

Training Course

X-ray techniques for materials development and process control

Non-destructive insights for advanced materials and processes

📅 22 Sep 08:45 - 24 Sep 2025 15:00

🌐 Online

Understanding materials from the macroscopic down to the atomic scale is essential for developing high-performance products and enabling robust and efficient production processes. Modern X-ray techniques provide a powerful, reliable, and non-destructive way to analyze materials. This training course provides a compact, application-oriented introduction to X-ray techniques at the laboratory scale and beyond, covering material structure, composition, and microstructural features can be efficiently characterized across all length scales. Emphasis is placed on X-ray microscopy and tomography, diffraction and spectroscopy, and how these methods provide advanced insights that support materials development and process control. New approaches to data analysis will also be covered, including AI algorithms. Participants will gain a solid, application-oriented foundation in X-ray physics and learn how to optimize experimental setups, particularly in the selection and use of X-ray tools.

Training Chair

Prof. Dr. Ehrenfried Zschech
Brandenburg University of Technology (BTU) Cottbus-Senftenberg

Lecturer

Prof. Dr. Ingo Flege
Brandenburg University of Technology (BTU) Cottbus-Senftenberg

Dr. rer. nat. Kristina Kutukova
PVA Technology Hub GmbH

Dr. Roald Tagle
Bruker Nano GmbH

Dr. Jörg Grenzer
Helmholtz-Zentrum Dresden-Rossendorf

Prof. Dr. David Rafaja
TU Bergakademie Freiberg

Dr. Janis Timoshenko
Fritz-Haber-Institut der Max-Planck-Gesellschaft

Target group

The training course is best suited for:

- Scientists, engineers, and technicians involved in research and development, industrial process and quality control seeking to enhance their expertise in X-ray techniques.
- Managers and sales professionals with a technical background looking to deepen their understanding of materials science and stay ahead in the industry.
- Professionals working with X-ray techniques or related fields who wish to advance their skills and knowledge in materials characterization and analysis.
- Scientists, engineers and technicians working in research and development as well as industrial production, process and quality control as well as at synchrotron beamlines.

Goals

X-ray techniques are essential for non-destructive process control and development leading to advanced materials in (high-tech) industries.
Here are the main reasons why this course will benefit your company:

- **X-Ray Basics**: Understand the fundamentals of X-ray physics, experiments and instrumentation.
- **Core X-Ray Techniques and Analysis**: Gain in-depth knowledge on X-ray diffraction, tomography, microscopy and spectroscopy for detailed materials analysis.
- **Advanced Data Analysis**: Understand how to apply advanced concepts, including artificial intelligence algorithms, to effectively interpret X-ray data.
- **Evaluate Applicability to your Process**: Discuss the capabilities and limitations of X-ray techniques based on specific use cases from academia and industry.
- **New Developments**: Keep up to date with the latest research and industry-specific solutions in areas such as metallurgy, renewable energy and microelectronics.
- **In-Situ and Operando Studies**: In-Situ and Operando Studies:Gain knowledge about materials ageing and kinetic processes such as microcrack propagation and fracture.

Use this opportunity to advance your company's technology and gain a competitive advantage!

Organizational matters

Overview

22 Sep 2025 (Mon)

09:00	Welcome and Introduction: Fundamentals of X-ray physics
11:15	X-ray experiments: Laboratory sources vs. synchrotron
14:00	X-ray experiments: Optics and detectors

23 Sep 2025 (Tue)

09:00	X-ray diffraction: Structure and microstructure of crystalline materials
11:00	X-ray tomography: 3D morphology and microstructure of materials
14:00	In-situ and operando X-ray microscopy studies

24 Sep 2025 (Wed)

09:00	X-ray fluorescence spectroscopy: Elemental composition
11:00	X-ray absorption spectroscopy: Local atomic and electronic structures of materials
12:00	Advanced analysis of data from X-ray spectroscopies
13:00	Final discussion

Program

22 Sep 2025 (Mon)

🕐 09:00   👤 Lecture
Welcome and Introduction: Fundamentals of X-ray physics

The Introduction and Program Overview provides participants with an overview of the content and structure of the training. A round of introductions encourages participants to get to know each other and share ideas during the session. It also allows participants to express their goals and expectations at the beginning of the training.

The course begins with a compact introduction to the fundamentals of X-ray physics. You will learn how X-rays are generated, their key properties, and how they interact with matter – an essential basis for all subsequent applications.

Prof. Dr. Ehrenfried Zschech
Brandenburg University of Technology (BTU) Cottbus-Senftenberg

🕐 10:45   ☕ Break
Break

🕐 11:15   👤 Lecture
X-ray experiments: Laboratory sources vs. synchrotron

Which X-ray source suits your research question? This session explains the differences between laboratory and synchrotron sources, highlighting their strengths, limitations, and typical applications – giving you practical decision-making support.

Dr. Jörg Grenzer
Helmholtz-Zentrum Dresden-Rossendorf

🕐 12:30   ☕ Break
Break

🕐 14:00   👤 Lecture
X-ray experiments: Optics and detectors

Optics and detectors are critical to the quality of any X-ray experiment. This session explains their design, function, and selection criteria, as well as tips for optimizing your setup for resolution and sensitivity to achieve high quality and accurate results.

Dr. Jörg Grenzer
Helmholtz-Zentrum Dresden-Rossendorf

23 Sep 2025 (Tue)

🕐 09:00   👤 Lecture
X-ray diffraction: Structure and microstructure of crystalline materials

X-ray diffraction (XRD) provides an in-depth look into crystalline materials. Learn how to analyze phases, determine crystallite sizes, and evaluate other microstructural features – from solid theoretical background to hands-on data interpretation.

Prof. Dr. David Rafaja
TU Bergakademie Freiberg

🕐 10:30   ☕ Break
Break

🕐 11:00   👤 Lecture
X-ray tomography: 3D morphology and microstructure of materials

X-ray tomography enables the non-destructive, 3D visualization of internal material morphology and microstructure. You will learn how to acquire, reconstruct, and interpret tomographic data for applications in quality assurance and failure analysis.

Prof. Dr. Ehrenfried Zschech
Brandenburg University of Technology (BTU) Cottbus-Senftenberg

🕐 12:30   ☕ Break
Lunch Break

🕐 14:00   👤 Lecture
In-situ and operando X-ray microscopy studies

In-situ and operando X-ray microscopy offers new insights into dynamic processes such as phase transitions, chemical reactions, or mechanical loads. You will learn how to apply this technique and how to integrate realistic operating conditions into your analysis.

Dr. rer. nat. Kristina Kutukova
PVA Technology Hub GmbH

24 Sep 2025 (Wed)

🕐 09:00   👤 Lecture
X-ray fluorescence spectroscopy: Elemental composition

X-ray fluorescence (XRF) allows reliable detection of elemental compositions. This session covers the fundamentals of XRF, its use in qualitative and quantitative analysis, and typical applications in materials testing and quality control.

Dr. Roald Tagle
Bruker Nano GmbH

🕐 10:30   ☕ Break
Break

🕐 11:00   👤 Lecture
X-ray absorption spectroscopy: Local atomic and electronic structures of materials

Explore in this session how X-ray absorption spectroscopy (XAS), including XANES and EXAFS, can reveal chemical states and local atomic environments. You'll learn how to collect and evaluate such data for materials investigations.

Prof. Dr. Ingo Flege
Brandenburg University of Technology (BTU) Cottbus-Senftenberg

🕐 12:00   👤 Lecture
Advanced analysis of data from X-ray spectroscopies

This module focuses on modern data analysis strategies for X-ray spectroscopy, including theoretical modeling and machine learning, including unsupervised and supervised approaches. You will learn how to interpret complex spectra and extract meaningful structural information efficiently to automate your analysis.

Dr. Janis Timoshenko
Fritz-Haber-Institut der Max-Planck-Gesellschaft

🕐 13:00   👤 Lecture
Final discussion

The final discussion provides an opportunity to reflect on the course, ask remaining questions, and exchange ideas on how to implement what you've learned in your own work environment.

Prof. Dr. Ehrenfried Zschech
Brandenburg University of Technology (BTU) Cottbus-Senftenberg

Ehrenfried Zschech is a consultant with hands-on experience in the fields of advanced materials, nanotechnology and microelectronics as well as process control and quality assessment. He holds honorary professorships for Nanomaterials at Brandenburg University of Technology Cottbus-Senftenberg and for Nanoanalysis at Dresden University of Technology. His activities include high-resolution X-ray imaging and the development of customized solutions for a broad range of applications including package failure analysis, metrology and inspection in microelectronics. Ehrenfried Zschech received his Dr. rer. nat. degree from Dresden University of Technology. He had several management positions at Airbus, at Advanced Micro Devices, at Fraunhofer and at the start-up deepXscan. Ehrenfried Zschech is Member of the European Academy of Science (EurASc) and Member of the of the German National Academy of Science and Engineering (ACATECH). In 2019, he was awarded with the FEMS European Materials Gold Medal, in 2023 with the DGM Pioneer Award and with the Roland Mitsche Prize.

Prof. Dr. Ingo Flege
Brandenburg University of Technology (BTU) Cottbus-Senftenberg

Dr. Jörg Grenzer
Helmholtz-Zentrum Dresden-Rossendorf

Jörg Grenzer is X-ray physicist and materials scientist, working at the Institute of Radiation Physics of the Helmholtz-Center Dresden-Rossendorf. His main interests are in growth processes of functional materials using laboratory X-ray or synchrotron radiation sources combining different analytical methods and, recently, the study of ultra-fast dynamical / non-equilibrium processes in materials, like laser or XFEL induced shock phenomena. He developed scientific instruments for both laboratory and synchrotron-based setups.

Dr. rer. nat. Kristina Kutukova
PVA Technology Hub GmbH

Kristina Kutukova received her PhD degree from the Brandenburg University of Technology Cottbus-Senftenberg, Germany, in 2023. She was awarded for her scientific work resulting in her PhD thesis "In-situ study of crack propagation in patterned structures of microchips using X-ray microscopy" with the DGM Young Scientist Award in 2023. Kristina Kutukova was a Research Associate in the Department of Microelectronic Materials and Nanoscale Analysis at Fraunhofer Institute for Ceramic Technologies and Systems, Dresden. Subsequently, she headed the Development and Application Lab at deepXscan GmbH, Dresden, with the main tasks to the develop customized solutions for high-resolution 3D imaging and to coordinate development projects. Kristina Kutukova expanded her knowledge in advanced microelectronic technologies by joining the Fraunhofer Institute for Reliability and Microintegration, Dresden. She took on the task as Head of the Application X-ray in the PVA Technology Hub GmbH, Branch Dresden, in September 2024.

Prof. Dr. David Rafaja
TU Bergakademie Freiberg

Solid state physicist Prof. Dr rer. nat. habil. David Rafaja (born 1965 in Prague) has held the Chair of Structure and Microstructure of Materials since 2003 and has been Director of the Institute of Materials Science at the Technische Universität Bergakademie Freiberg since 2005. From 2009 to 2014, he was coordinator and spokesperson of the Saxon Cluster of Excellence "Functional Structural Design of New High Performance Materials by Atomic Design and Defect Engineering (ADDE)", from 2017 to 2023 one of the spokespersons of the "Saxon Alliance for Material and Resource Efficient Technologies (AMARETO)", and since 2022 he has been Dean of Studies for the Master's programme "Advanced Materials Analysis" at the TU Bergakademie Freiberg. His research topics include microstructure design, defect engineering and the further development of methods for structure and microstructure analysis, in particular the further development of diffraction methods.

Dr. Roald Tagle
Bruker Nano GmbH

Dr rer. nat. Roald A. Tagle Berdan has been globally responsible for X-ray fluorescence applications at Bruker Nano since 2022. He was born in Havana, Cuba, in 1973. After studying chemistry in Leipzig and obtaining his doctorate in geochemistry and cosmochemistry in 2004 (Berlin), he conducted research as a Post Doc. Fellow of the German Academy of Sciences LEOPOLDINA at various institutions in Germany, Canada and Belgium. Since 2007 he has been working at Bruker Nano GmbH in the field of spatially resolved X-ray fluorescence analysis and is dedicated to the further development of this technology.

Dr. Janis Timoshenko
Fritz-Haber-Institut der Max-Planck-Gesellschaft

Janis Timoshenko is the leader of the "Operando Hard X-ray spectroscopy" group at the Department of Interface Science of the Fritz-Haber Institute of the Max-Planck Society in Berlin, Germany. He received his PhD in solid state physics in 2015 from the University of Latvia, where he worked under the supervision of Prof. Alexei Kuzmin on the development of advanced approaches to EXAFS data analysis. He then went for postdoctoral positions at the Physics Department of Yeshiva University and the Department of Materials Science and Chemical engineering of Stony Brook University, New York, USA, where he worked on the in situ investigation of nanomaterials using synchrotron radiation under the lead of Prof. Anatoly Frenkel. In 2018 he joined the Department of Interface Science at the Fritz-Haber Institute under the direction of Prof. Beatriz Roldan Cuenya. His primary research interests are synchrotron-based investigations of catalyst transformations under working conditions, as well as the development of simulation-based and machine learning-based approaches for XAS data interpretation. In 2022 he received the Young Scientists Award for Theory and Instrumentation (Farrel Lyttle Prize) from the International X-ray Absorption Society.

Contact person

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🌐 https://dgm.de/akademie/en/events/x-ray-techniques-
for-materials-development-and-process-control-2026