Why are teeth so strong? Why do implants break? How long do hydrogen engines last? The Institute of Physics and Materials Science at BOKU University has been addressing such exciting questions for 20 years.

Following the division of the former Institute of Meteorology and Physics, the institute was founded at the Türkenschanze site and is part of the Department of Natural Science and Sustainable Resources. Since then, it has made significant contributions to energy transition, bioeconomy and sustainability.

Groundbreaking research infrastructure and projects

One of the most recent highlights is the establishment of the 'In-situ Material Characterisation Laboratory' with a volume of 1.78 million euros, financed as part of the 2023 R&D infrastructure funding by FFG and EFRE. Another highlight is the Christian Doppler Laboratory for 'Defect tolerance of steels in the range of high and very high stress cycles', which was founded in May 2024. Previously, projects such as the 'X-Ray Colour Camera Microscope', the CD Laboratory for 'Fundamentals of Woodworking Processes' and around 50 other research projects with budgets of more than €100,000 for the institute laid the financial foundation for excellent research at the institute.

Pioneering work in ultrasound technology and materials research

The roots of the Department of Physics at BOKU date back to 1989, when Professor Stefanie Tschegg established it and later founded the institute. From the outset, a key area of research has been ultrasound technology, led by Associate Professor Herwig Mayer. High-frequency fatigue testing methods are being developed in collaboration with universities and companies in the USA, Germany, Japan and Finland. The aim is to define stress limits for materials used in energy, transport and medical technology in order to prevent damage even after long periods of use and to ensure the sustainable use of materials. A current focus is on the investigation of materials for the energy transition, for example using a newly developed ultrasonic setup for testing in hot hydrogen.

Innovations in biomaterial research and nanostructure analysis

With the appointment of Professor Helga Lichtenegger in 2011, the institute expanded to include biomaterial research. She introduced X-ray physics methods for nanostructure characterisation, which are particularly suitable for analysing hierarchical structures in biological materials. Research projects investigating bone growth around implants, the structure of silk for nerve regeneration, metal enrichment in mosses and the development of biomimetic technical nanocomposites benefit from these high-resolution methods. A joint research field of the entire institute is the in situ investigation of crack formation in superelastic materials using synchrotron radiation and ultrasonic loading.

The methods developed at the institute are used worldwide and promote interdisciplinary cooperation, including within BOKU. Examples include the ultrasonic characterisation of soil aggregates, the testing of concrete and adhesives, the analysis of colloidal materials and proteins, and research into the physical properties of wood and cellulose-based materials.

The future of materials science

Teaching at the institute conveys scientific thinking and enthusiasm for topics in physics and materials science. The courses on offer range from basic lectures in physics for six of the seven bachelor's programmes at BOKU to specialised courses on materials characterisation, biomaterials and applied physics in six master's programmes. In addition, the Institute is prominently represented

in the Doc School ‘Biomaterials and Biointerfaces’ and its management. Future challenges include the integration of AI into teaching and the establishment of a core facility for ‘Material Testing and Characterisation’.

The Institute of Physics and Materials Science remains a place where students and researchers can understand the behaviour of materials through their micro- and nanostructure, while enjoying scientific discovery and research.