We help you see materials from the inside

TU Delft Reactor Institute is the largest provider in the Netherlands of research and education using radiation and nuclear techniques for energy, health and materials. The demand for these applications in our society is strongly increasing given developments in these areas.

TU Delft

TU Delft Reactor Institute

The institute consists of the reactor institute (RID) and the scientific department Radiation, Science & Technology (RST). Together, they have been the Dutch knowledge centre for research and education in radiation and nuclear techniques for more than 60 years. With our knowledge and expertise, we make an important contribution to scientific research using neutrons, positrons, electrons, protons, gamma radiation and radioisotopes.

Materials research and development: energy, batteries, health and food

Our research reactor has undergone major improvements in recent years, including the installation of a cold neutron source (CNS), and the developments and adaptations of our unique research instruments. As part of the open TU Delft university community, we make our unique facilities available to universities, research institutes and industry for cutting-edge research, both nationally and internationally.

A major part of the research focuses on the development of new materials for sustainable energy such as solar cells, batteries and efficient cooling/heating. We also work on health applications, such as the production of medical isotopes for cancer diagnostics and treatment. Meat substitutes are also part of our research. In addition, we do research on safe and sustainable nuclear energy.

Education and training

Our educational activities include the training of bachelor, master and PhD students. We also offer a wide range of courses in the fields of radiation protection and nuclear measurement techniques. **TU Delft Radiation Education** is the largest dedicated training provider in the Netherlands in the field of radiation protection, the discipline that ensures that people work safely with radiation.

Any questions?
Need advice on which instrument is right for your materials analysis needs? Check out our website and contact us!
https://edu.nl/p4uhw

Research Instruments

Research using the reactor or other related radiation instruments offers a wide range of possibilities to research materials. We specialise in the use of neutrons, positrons and gamma rays in our advanced scientific instrumentation to provide a cutting edge in materials research for academia and industry. The instruments are designed to measure specific structures taking place at specific length scales, from the atomic level to molecules, polymers, proteins, cells up till artefacts as depicted in figure 2.

PEARL Diffractometer

PEARL is a medium-resolution, general-purpose neutron diffractometer and ideal for conducting diffraction experiments on powdered samples, with varying sample environment capabilities (temperature ranging from 1.7 Kelvin to 1500 Kelvin). This makes the instrument highly capable and scientifically diverse for studying temperature-dependent structural and/or magnetic transitions. The wide range of applications includes, but is not limited to, energy materials, magnetic materials, high-entropy alloys, magneto-caloric materials.

Positron suite

Positrons generated in the intense gamma radiation field of the reactor core are directed towards a sample using electric and magnetic fields. By analysing the radiation emitted from their annihilation with electrons, information about the local atomic structure can be obtained. Positrons are among the most sensitive probes for detecting material defects or dislocations, providing crucial information for the development of next-generation materials for applications such as solar cells or nuclear fission and fusion reactors.

ROG Neutron Reflectometer

The ROG Neutron Reflectometer measures the way neutrons are reflected by flat surfaces and interfaces with the aim to provide information about the thickness, composition and roughness of thin films and other layered structures. It can be used to study (stacks of) layers with thicknesses of 5 - 150 nanometres while providing a resolution up to 0.2 nanometres. Neutron reflectometry can be used to non-destructively study both liquid and solid samples in a variety of different experimental conditions.

SANS Small Angle Neutron Scattering

SANS is a powerful technique to study the structure of opaque materials at size ranges of nanometres to 0.1 micrometres. Various components can be highlighted through the variation of the scattering contrast with selected deuteration. SANS is primarily used for projects in molecular biology and soft matter science such as colloids, polymers, macromolecules & membranes and biological systems.

SESANS Spin-Echo Small Angle Neutron Scattering

SESANS technique is a new efficient method to measure structures of materials in real space. Structures can be determined over three orders of magnitude in length scale, from 10 nanometres to 20 micrometres, which is two orders of magnitude larger than conventional Small Angle Neutron Scattering (SANS).

FISH Neutron Imaging

FISH (First Imaging Station Holland), thermal and cold, are two medium-resolution neutron imaging facilities installed at Delft University of Technology. These instruments serve as a key resource for national and international scientific, education and industry applications. The technique offers non-invasive, in-operando 2D and 3D neutron imaging capabilities, enabling detailed analysis of the bulk of samples at length scales ranging from micrometres to decimetres. Designed to support a diverse range of scientific investigations, the FISH instruments enable the comprehensive studies of materials and structures. They aim to facilitate a wide range of applications, such as internal structure of concrete and engineering materials, inspection of lubricants in engines, internal corrosion inspection, micro-structure of crystallisation in steel welds, cracks in composite materials, in-situ study of Li ion batteries, cultural heritage, water uptake in plant roots and soil, rocks etc.

Irradiations

Irradiation can be used to modify material properties, accelerate ageing, induce radioactivity for medical applications or analysis. Strict legislation is always applied when radioactivity is to be induced. Materials can be irradiated with neutrons, high energy gamma rays, i.e. photons from the reactor core itself, gamma rays from an intense ^{60}Co source, and pulsed accelerated electrons from the Van der Graaff accelerator. A unique application of inducing radioactivity by irradiating samples in the reactor core is Instrumental Neutron Activation Analysis (INAA) which is a chemical analysis technique that allows determination of multi-element concentrations by nuclear processes using gamma spectroscopy. It is one of the very few techniques capable of determining the concentration of halogens (fluorine, chlorine, bromine, iodine).

Cold Neutron Source (CNS)

The impact of the recently installed CNS is clearly demonstrated by this neutron spectrogram, Figure 1, measured using the Neutron Reflectometer. The peak intensity of the cold neutron spectrum (blue line) is shifted towards longer wavelengths compared to the orange line without CNS. Additionally, due to more efficient transport of cold neutrons, the total intensity at the sample position has increased. As a result, the sensitivity (contrast) is enhanced, and the measurement time is greatly reduced - from several hours to just a few minutes.

Figure 1

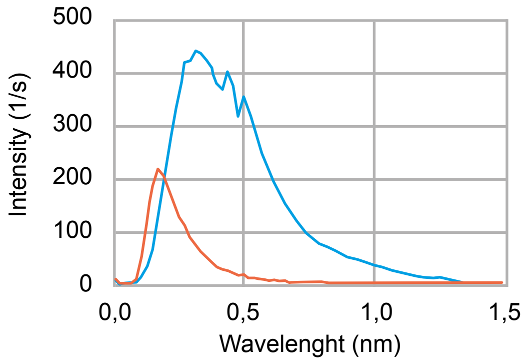
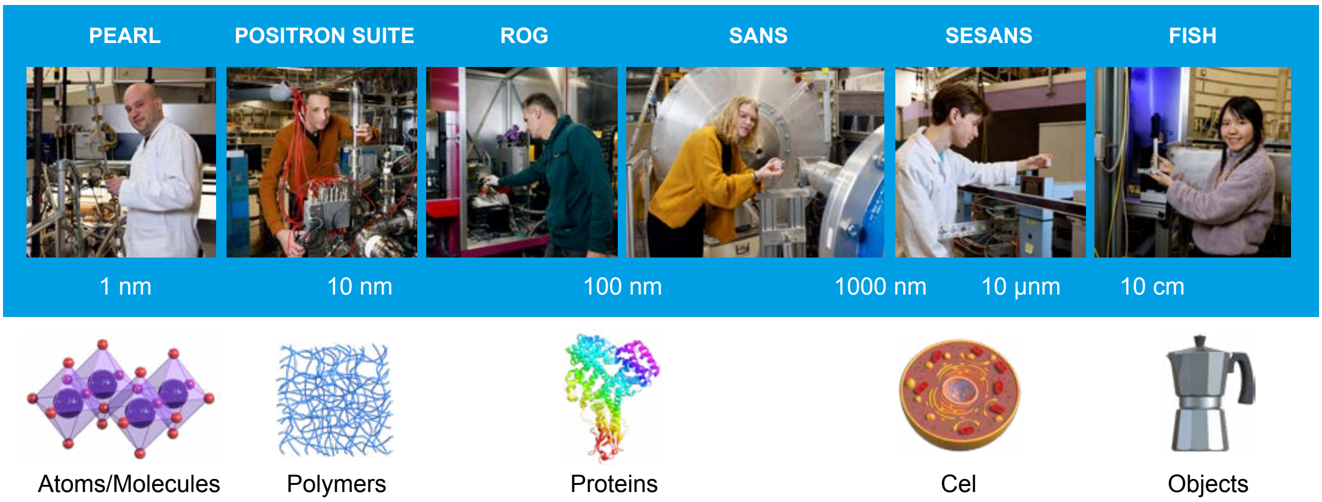


Figure 2 Different instruments for studying materials at different length scales



More information

Would you like to learn more about TU Delft Reactor Institute?
https://edu.nl/8kfnd

Would you like to learn more about the opportunities TU Delft Reactor Institute has to offer for product and materials research?
https://edu.nl/wvrb8

Would you like to know more about cursory education options?
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