Living in a Materials World

Introduction

ISIS is a multi-disciplinary research centre used by a wide range of scientists from the Physics, Earth Science, Chemistry, Materials Science, Engineering and Biology communities.

Scientists come here because ISIS is a powerful tool for investigating materials at the atomic level. It can be used to study where atoms are (structure) and what atoms are doing (dynamics).

ISIS, a major facility at the STFC Rutherford Appleton Laboratory site in Oxfordshire, is the size of several football pitches and uses enough electricity to run a small town.

It is a user facility, which means that visiting teams of scientists can use the dedicated, fully supported instruments at ISIS to help further their research.

Every year, over 1500 visiting scientists from 30 different countries use the facilities to perform around 600 different experiments.

The properties of materials are controlled by their make-up at the atomic level.

Whether we think of the strength of steels or the brittleness of ceramics; the electrical conductivity of copper or the insulating properties of plastics; the magnetism of iron or the immiscibility of oil and water – all these characteristics are controlled by the type and arrangement of atoms which make up the materials.

An understanding of why individual substances behave as they do is fundamental to the development of new materials with properties tailor-made to specific applications.

Producing new superconductors, which conduct electricity with no loss of energy, or developing the next generation of computer storage media, require us to understand the atomic-level workings of existing materials.

Aerial view of the ISIS Facility

At ISIS, particle accelerators provide beams of neutrons and muons to enable the structure and dynamics of condensed matter to be probed on a microscopic scale that ranges from the subatomic to the macro-molecular.

Think of ISIS as an extremely powerful magnifying glass that uses neutrons (rather than light) and mathematics (rather than glass) as its lens, to produce images of where atoms are and how they are moving.

At ISIS, beams of neutrons are made using a process called spallation, in which a high-energy proton beam hits a target made of a heavy metal. The collision causes neutrons to be emitted from the nuclei of the metal atoms.

ISIS produces ten thousand million million neutrons per second and is the world's most powerful pulsed spallation neutron source.

Neutrons make ideal tools for exploring matter at the atomic level. We send neutrons into a material and detect them when they come out.

In neutron diffraction, the directions in which the neutrons emerge tell us about the arrangement of the atoms inside.

In neutron spectroscopy the amount of energy lost by the neutrons during their passage through a material tells us about the atomic dynamics.

You will find out more about how neutrons are produced and used at ISIS in the following sections.