NUCLEAR SCIENCE

PART OF YOUR EVERYDAY LIFE

Nuclear science is the study of the world at the atomic level. As everything is composed of atoms, it follows that the science that helps us understand the atomic world, nuclear science, can be applied to just about everything, playing an important role in our daily lives.

Fighting obesity

The vast majority of the fats consumed in the Western world are triglycerides. Nuclear researchers are using a technique called small angle neutron scattering (SANS) to investigate how triglycerides are digested in the gut in the presence of enzymes and bile salts.

ANSTO's SANS instrument, Quokka, uses neutrons produced in ANSTO's OPAL multi-purpose reactor to direct a beam of neutrons at a sample to measure the number of neutrons that scatter and by how much. The results can reveal how fats are absorbed by the body, and which fats are the healthiest to use in food manufacturing. Not only is SANS being used to understand how triglycerides are digested, but also how alternative, healthier molecules could be used as a substitute for foods high in fat, such as margarines.

Monitoring air pollution

Nuclear science can be used to characterise and track the source of fine-particle air pollution – a key step towards understanding how to improve air quality. Particle samples are collected on thin, stretched Teflon filters and their elemental composition analysed using a multiple accelerator-based ion beam analysis technique. More than 20 different chemical species can be identified, including elements from hydrogen to lead.

Every week, ANSTO tracks and publishes data on air pollution. The data comes from key sites around Australia and the world, including megacities in Asia where air pollution is an increasing problem. ANSTO researchers are able to quantify the effects of air pollution. This information is invaluable for planners when it comes to making decisions that impact the quality of the air we breathe.

Investigating water resources

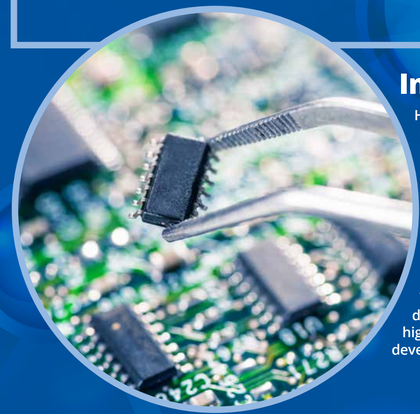
As demand for water increases, its management becomes more crucial to government, industry and the Australian public. Nuclear researchers are helping by tracing water movement through the hydrological cycle using 'isotope signatures'. Different ratios of oxygen, hydrogen and carbon isotopes found in water depend on factors such as the rock it has flowed through and the time it has spent in streams or underground. By measuring signatures of groundwater, researchers can model the movement of the water and calculate how long it has spent in underground aquifers. ANSTO researchers are studying groundwater on Rottnest Island in Western Australia to assess its isotopic composition. This study is looking into whether the water underlying the island can be used as a sustainable resource by determining how much groundwater there is and how quickly it is being replenished. This includes measuring the naturally-occurring isotope tritium as an indicator of the water's age.

Making your journey home safer

Joints are usually the 'weakest link' in a variety of transport modes – from bikes to cars, trains, aircrafts and even space shuttles. Advanced manufacturing techniques like laser welding and metallic 3D printing are being used to not only find the areas that are stressed and weak but to assess techniques to remove or optimise those critical stresses. Neutron diffraction beamlines serve as a "powerful microscope" which enable researchers to see the deformation and imperfection in the metallic structures at the atomic level, allowing optimisation of complex joining processes.

The neutron imaging and SANS beamlines at ANSTO are used by researchers to develop new monitoring techniques to improve the overall safety and reliability of the transport industry.

Improving silicon technology



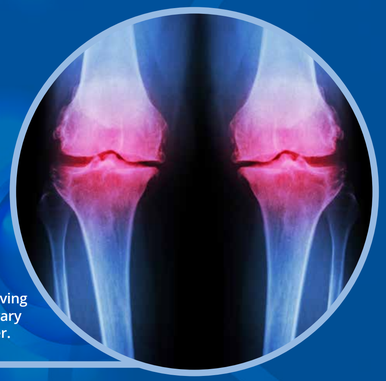
High-quality silicon chips are at the heart of everyday technology such as computers, smartphones and digital cameras. At ANSTO the OPAL multi-purpose reactor is used for neutron transmutation doping (NTD) of ultra-pure silicon ingots. This product is also known as NTD Silicon and is mainly used for the manufacturing of high to very high power devices.

When silicon is exposed to neutrons for precise periods of time, the electrical properties change so that the ability to conduct electricity is improved. This occurs when some of the silicon atoms are hit by neutrons causing a mutation into atoms of phosphorous. The silicon irradiated at ANSTO is used in microelectronic switching devices in a range of applications such as power infrastructure, high-speed trains, some hybrid cars and to facilitate the development of renewable sources of energy, such as wind.

Stopping soil erosion on Australian vineyards

ANSTO researchers are using nuclear techniques to determine the extent of soil erosion on an Australian vineyard. The research is also part of the International Atomic Energy Agency (IAEA) Regional Cooperative Agreement Project on improving soil fertility, land productivity and land degradation mitigation. With soil samples, researchers can determine the extent of erosion and have an indication if erosion control measures have been effective. They do this by using specific environmental tracers found in the soil: lead-210, beryllium-7 and caesium-137. Tracers should be present in the soil and decay with depth. The extent of the isotope signal in the samples is compared to everything that might have been lost or gained in the soil against a reference site.

Developing advanced bone imaging techniques



Stress fractures, osteoporosis, tumour spread and bone infections can be diagnosed by a method known as scintigraphy. In this technique, a patient is injected with a radioactive isotope attached to a bone-seeking molecule, then scanned with a 'gamma camera' to highlight small bone abnormalities. Imaging techniques with nuclear medicine produced in ANSTO'S OPAL multi-purpose reactor can be used to target tumours or other diseases and to assess the functional status of tissues.

Nuclear medicine is used to provide doctors with a quick and accurate diagnosis of a wide range of conditions involving different parts of the body including the brain, heart, salivary glands, thyroid, lungs, liver, spleen, kidney and gall bladder.

Keeping your food tasty

Nuclear science can be used for the preservation or disinfestation of food by irradiation with gamma rays, or high energy X-rays. This process involves exposing the food to a prescribed amount of radiation to destroy bacteria, eliminate pests or extend the shelf life of the food. Irradiation is used as an alternative to post-harvest use of pesticides that could leave residues on fruits and vegetables. Treatment by irradiation is also safe. Irradiated food does not leave residues or become radioactive.

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Nuclear-based science benefiting all Australians

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