CASE STUDY

ANSTO

Supporting semiconductors from high grade silicon inputs to applications in energy, transport, space and beyond

Preparing silicon ingots for irradiation in OPAL
Image courtesy of ANSTO

Semiconductor technologies require specialised infrastructure to ensure they can be manufactured, tested and used reliably.

Australian Nuclear Science and Technology Organisation (ANSTO) supports the semiconductor sector in two distinct ways: through its silicon irradiation service, which forms part of global power semiconductor manufacturing supply chains, and by providing national infrastructure that researchers and industry can access to develop, characterise and optimise materials used in semiconductor technologies.

ANSTO's Lucas Heights facility in NSW is home to OPAL, Australia's only multi-purpose nuclear reactor. OPAL is part of Australia's nationally significant scientific infrastructure, supporting health, industry, research and technology.

Using OPAL, ANSTO irradiates high-purity silicon (also known as neutron transmutation doped (NTD) silicon) by changing some of the silicon atoms to phosphorus to dope the material, giving it semiconductor properties. ANSTO has been irradiating NTD silicon since 1986, and OPAL was specifically designed to continue this important capability. "We are considered the world leader in this area by volume and quality," said Oleh Nakone, ANSTO's Group Executive, Nuclear Medicine and Commercial.

Creating NTD silicon changes the material's electrical properties in a very precise way, making it useful for a variety of technologies, such as power semiconductors. Power semiconductors enable critical components used in high-speed rail, wind turbines and 'smart' power grids that manage complex energy flow between dispersed energy sources. This includes solar and wind farms, conventional sources and even domestic photovoltaics, reliably connecting to end users. As a result, the unique properties of NTD silicon make the material important to Australia's energy transition.

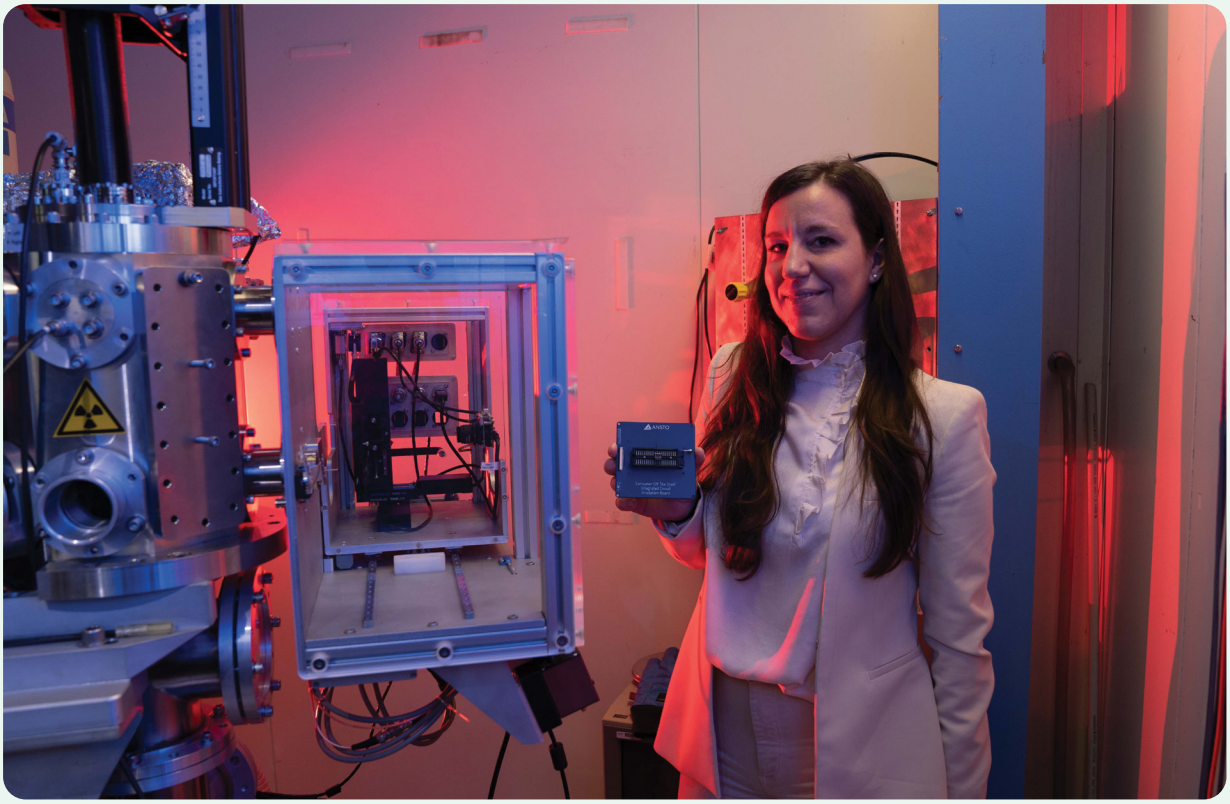
"Energy no longer just flows from the source to your house or industry. Now, there is a multi-directional flow – your house may also be generating energy. Grids now need to be able to handle complex supply and demand systems," Mr Nakone said. "Power semiconductors are key to this."

Australia has limited silicon manufacturing. Instead, overseas foundries send silicon to ANSTO for irradiation before it is returned for further processing. This places Australia directly within an international power semiconductor manufacturing supply chain and demonstrates how Australia's capability can support global technologies.

Beyond manufacturing, ANSTO provides a suite of facilities for radiation testing and development of semiconductor materials and devices. These facilities include the Centre for Accelerator Science, Gamma Technology Research Irradiator, the Australian Centre for Neutron Scattering, and the Australian Synchrotron in Victoria. These facilities provide access to advanced scientific instruments and all the types of radiation that semiconductor devices can encounter in space. This includes protons, ions, gamma radiation, X-rays and neutron beams, which support critical technology R&D across academia, industry and government.

ANSTO's facilities can evaluate the performance of semiconductor technologies under harsh radiation environments, such as those found in space, aviation or nuclear applications. This helps test whether they can withstand these environments and optimises their performance under these conditions. For example, a research group from Swinburne University used facilities at the Centre for Accelerator Science to understand the impact of radiation damage on the performance of memory and micro processing chips used in space satellites.

"We support Australian industry to grow and compete on a global scale," said Mr Nakone. "The radiation testing and hardening business is undergoing a period of growth. Australia, with its partners, entered the space race a couple of years ago. Overseas facilities can be extremely expensive, overbooked and not easily accessible," Mr Nakone explained. "Having this infrastructure domestically available is part of Australia's broader investment into sovereign capability, national resilience and building a more competitive and resilient sector."



Radiation testing chamber sample
Image courtesy of ANSTO