Planning for a nuclear future

February 17 2011

Materials scientists and engineers from six UK universities are joining forces to forecast the life expectancy of nuclear power reactors.

Researchers from the University of Leeds have teamed up with colleagues from the Universities of Manchester, Nottingham, Salford, Sussex and Huddersfield to examine how daily radiation exposure gradually damages the graphite blocks that sustain nuclear chain reactions.

Their findings should allow the nuclear utility companies that run the UK's existing fleet of nuclear reactors to plan for the future. The work should also show whether the next generation of very high temperature reactors, which are expected to become an important source of clean hydrogen-based power, will last as long as expected.

Graphite is a key component of most working nuclear reactors in the UK and for the most exciting designs of new high temperature reactors. The graphite blocks act as a brake for high-speed neutrons, slowing them down to speeds that are most effective for nuclear fission.

Not surprisingly, the daily neutron bombardment takes its toll on these graphite 'moderators'. The clusters of linked carbon atoms - or crystallites – that make up the graphite change their shape and the blocks become more porous. Knowing exactly how the material changes and over what timescale will help engineers predict how long the moderators can do their job properly, how manufacturing processes could be improved and how some of the damage to the graphite blocks might be reversed.

"We know so much more now about the layered structure of graphite than we did in the 1960s and 1970s when researchers started to study its material properties. Radiation damage may cause these hexagonal carbon nets to buckle or fold and this is something that we will have to take into account," said materials scientist Dr Aidan Westwood who, together with Dr Andrew Scott, is leading the work at the University of Leeds.

Researchers at each of the partner universities will be using a variety of experimental and simulation techniques to study irradiated graphite at a number of different length scales. These will include transmission electron microscopy, Raman and electron spectroscopy and X-ray tomography. The results will be pooled and used to develop computer models that can predict the behaviour of entire components under likely operating conditions.

"A multiscale approach is essential," said Dr Andrew Scott. "The distance between two carbon atoms in a graphite layer is about one seventh of a nanometer, whereas the length of a typical graphite block is one metre. We need to build up a complete picture, starting from what the neutrons do to individual atoms, to the layers of linked atoms, to the crystallites of interlocked layers, and finally to the component as a whole."

"The equipment we now have at our disposal is far more powerful than the microscopes that researchers have previously used to study these materials," said Professor Rik Brydson, a co-investigator on the project. "We will be using state-of-the-art techniques to image the layers of graphite in atomic detail."

The project, which will run for three years, is being funded by a £1.3 million grant from the Engineering and Physical Sciences Research

Council (EPSRC). It will involve around 25 academics, postdoctoral researchers and postgraduate students across the six universities and key industrial partners from the nuclear industry.

"There has been very little focus on this type of nuclear research in the UK for 40 to 50 years," Dr Scott commented. "It is vital that we start training-up a new generation of nuclear engineers. This project will go some way towards doing that."

Provided by University of Leeds

Citation: Planning for a nuclear future (2011, February 17) retrieved 25 April 2024 from https://phys.org/news/2011-02-nuclear-future.html