ICAM2009
11th International Conference
on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25

Research in the UK into reactor structural materials degradation mechanisms

C.A.English*

National Nuclear Laboratory, Harwell, Didcot Oxfordshire OX11 0QJ, UK.
* Corresponding author.

Abstract – . This describes the recent renaissance in materials research in both industry and academia for nuclear power applications, and highlights on-going initiatives and recent technical achievements including the application of advanced microstructural techniques.

Experience over the last 60 years both in the UK and world-wide has shown that understanding the evolution of materials properties in nuclear applications is an essential requirement for maintaining the current fleet, for assessing and developing new designs, and for developing appropriate waste management strategies [1]. However, the materials skills and capability base in these areas has been declining for many years, and dispersed among many institutions [2]. Recently, there has been a real ressurgence of interest in the UK in materials research for nuclear power applications and this is the subject of this paper.

The current focus of materials R&D in the UK comprises the whole of the Nuclear Fuel Cycle for Generation II and III reactors (Figure 1). This requires the understanding of a wide range of materials responses to a range of environments and loading conditions, including exposure to high temperatures, neutron irradiation, external (and internal) stresses, corrosive liquids. The research challenges for existing reactors include understanding and predicting the degradation of specific materials, such as the AGR graphite core and boiler components. For future reactors there is the need to undertake R&D into component fabrication and joining (including weld simulation), and prediction and assessment of materials degradation.

The UK now maintains leading materials expertise across both the academic and industrial sectors, with key initiatives such as The Dalton Nuclear Institute (The University of Manchester) the EPSRC's "Keeping the Nuclear Option Open" (KNOO), and The National Nuclear Laboratory (NNL). The scope of these and similar intiatives will be described in the paper.

Historically, in the UK the small number of Magnox reactors and the wide range of specific operating temperatures and neutron fluences/fluxes meant that benefit could not be gained from work elsewhere. This necessitated, for example, a mechanistic approach to predicting the degree of reactor pressure vessel embrittlement from experiments on irradiated specimens. Thus the R&D in the UK into specific degradation mechanisms has been characterised by a focus on developing detailed mechanistic insight and building physically based models of the through-life changes to material properties. Examples of the approach adopted and recent technical advances will be given in the fields of RPV embrittlement, stress corrosion cracking, and oxidation of Zr alloys. A characteristic feature of the work is the use of advanced microstructural techniques, (see figure 2 for an example of a cluster in an irradiated pressure vessel steel).

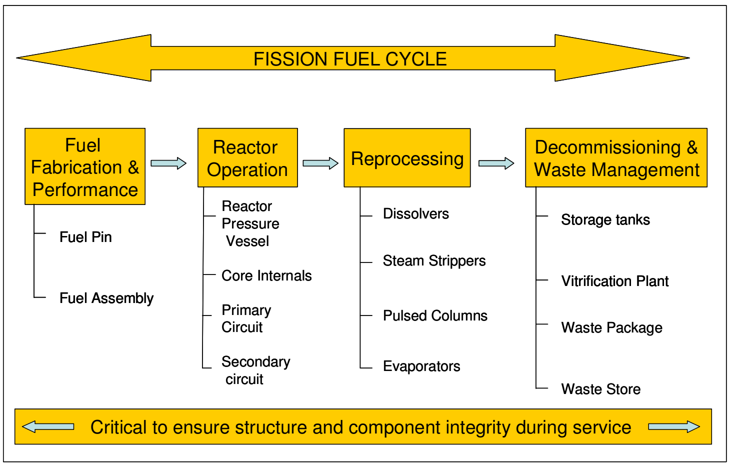

Figure 1: Main activities and components of the fission fuel cycle [1].

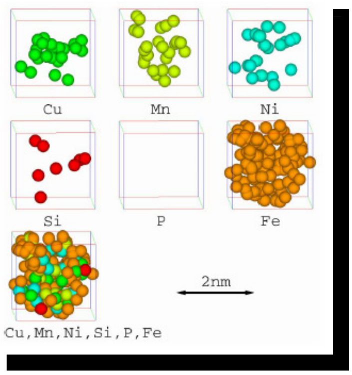

Figure 2: Atom map showing the presence of a 3nm irradiation induced cluster containing copper manganese, nickel and silicon atoms in a RPV steel.

[1] I Cook, C English, P E J Flewitt and G Smith, "Nuclear energy materials research", *Materials UK* Energy Review, 2007..
[2] S A Court, "The mapping of materials supply chains in the UK's power generation sector", *Materials UK* Energy Review, 2008.