Development of Novel Treatments for Carbon-Based Radioactive Waste

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There is no current plan for the long-term disposal of carbon-based radioactive wastes from the nuclear fuel industry, largely due to the long half-life (5730 years), environmental mobility and bio-availability of radiocarbon (^{14}C). In the UK, much of this waste exists as irradiated graphite which may also contain other radionuclides such as ^{3}H, ^{36}Cl and ^{60}Co. The UK radioactive waste inventory currently contains 83000 tonnes of intermediate level waste (ILW) and 1400 tonnes of low-level waste (LLW) as graphite [1]. More waste will also be generated as older reactors are decommissioned and new reactors are built. For the UK, this is predicted to result in an additional 78000 tonnes ILW and 9000 tonnes LLW as graphite and is estimated to comprise approximately 35% of the total ILW packaged waste volume [1].

We have been developing a novel, two-stage process to treat radioactive graphite waste. The initial stage involves thermal processing of the graphite using an innovative smouldering technique [2]. The waste generated from this will include gas containing radionuclides such as $^{14}CO_2$. The second stage involves capturing and transforming the radionuclides to a mineral state. Ongoing investigations are considering microbial induced calcite precipitation (MICP) using the enzyme carbonic anhydrase which has been shown to increase calcite precipitation rates [3]. Preliminary results have indicated that between biotic and abiotic systems there are different calcite crystal morphologies and different precipitate characteristics.

[1] NDA (2016) Radioactive Wastes in the UK: UK Radioactive Waste Inventory Report. [2] Switzer *et al*. (2009) *Environ. Sci. Technol.* **43** (15), 5871-5877. [3] Ramanan *et al.* (2009) *World J. Microbiol. Biotechnol.* **25**, 981-987.