Simple method of dealing with harmful radioactive iodine discovered

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A novel way to immobilise radioactive forms of iodine using a microwave, has been discovered by an expert at the University of Sheffield.

Iodine radioisotopes are produced by fission of uranium fuel in a nuclear reactor. Radioactive iodine is of concern because it is highly mobile in the environment and selective uptake by the thyroid gland can pose a significant cancer risk following long term exposure. Furthermore, iodine-129, which is a type of radioactive iodine, has an extremely long half life of 15.7 million years, so is one of the most significant long term hazards faced by the population due to its emission during the geological disposal of nuclear waste.

Professor Neil Hyatt, from the University's Department of Materials Science and Engineering, has now found a way of locking up iodine radioisotopes in a durable, solid material suitable for ultimate disposal, like lead iodovanadinite($Pb_5(VO_4)_3I$). The research, which was published in the *Journal of* Nuclear Materials, demonstrates how his simple, inexpensive and rapid method can be done at atmospheric pressure.

Professor Hyatt and his team created a solid material for immobilisation of iodine with the formula $Pb_5(VO_4)_3I$, by heating a mixture of lead iodide, lead oxide and vanadium oxide.

Previously, this has only been achieved using high pressure and a sealed container, because iodine is volatilised at high temperature. However, using the knowledge that vanadium is a good absorber of microwaves at 2.45 GHz – the frequency used in domestic microwave ovens – the team were able to heat the mixture of chemicals in a microwave oven to produce $Pb_5(VO_4)_3I$ in about three minutes.

The key to the method's success is that $Pb_5(VO_4)_3I$ is a poor absorber of 2.45 GHz microwaves, so once this is formed, the sample cannot absorb microwaves, so the temperature does not get high enough for the iodine to volatilise.

Iodine-131 was the harmful gas emitted from the Fukushima power plant in Japan following the earthquake and tsunami last month, and was a significant contributor to the health effects from open-air atomic bomb testing in the 1950s, and was also emitted during the Chernobyl disaster. It is hoped the new research will reduce the public health impact associated with the release of radioactive iodine to the environment by providing a simple and inexpensive method of immobilisation in a solid material, which could be rapidly deployed in an accident scenario.

Professor Neil Hyatt, said: "In spent nuclear fuel, the iodine is not immobilised, so once the containment is breached it simply gets dispersed. At present, iodine-129 released by nuclear fuel reprocessing is discharged direct to the Irish Sea off the coast of Sellafield. Substantial quantities of this radioisotope were also released into the sea off the coast of Japan in the Fukushima incident. Our new method offers a way of safely and rapidly containing this radionuclide, reducing the potential long term impact on human health from discharge to the environment."

More information: Rapid synthesis of Pb5(VO4)3I, for the immobilisation of iodine radioisotopes, by microwave dielectric heating, doi:10.1016/j.jnucmat.2011.04.041

Abstract

Rapid synthesis of Pb5(VO4)3I, a potential immobilisation host for iodine radioisotopes, was achieved in an open container by microwave dielectric heating of a mixture of PbO, PbI2, and V2O5 at a power of 800 W for 180s (at 2.45 GHz). The resulting ceramic bodies exhibited a zoned microstructure, differentiated by inter-granular porosity and phase assemblage, as a consequence of the inverse temperature gradient characteristic of microwave dielectric heating. Liquid PbI2 within the interior of microwave processed ceramics assisted formation of Pb5(VO4)3I, and reduced inter-granular porosity. In contrast, the exterior of microwave processed ceramics comprised poorly sintered Pb5(VO4)3I with the presence of minor reagent relics. Quantitative microanalysis, electron diffraction and Rietveld analysis, confirmed the synthesis of stoichiometric Pb5(VO4)3I within precision. The crystal structure of Pb5(VO4)3I was found to adopt space group P63/m with a = 10.4429(3) Å and c = 7.4865(2) Å.

Provided by University of Sheffield

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