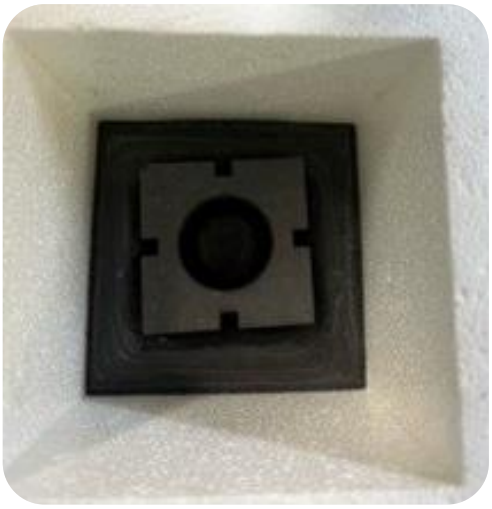
TECHNICAL SPECIFICATION SHEET

MALLET™ - MIDAR®-Augmented Lower-cost Lower-carbon Encapsulation Technique for Graphite

Background

- NUVIA and Lucideon have worked on the development of MALLET™, a novel geopolymer formulation for the encapsulation of radiologically contaminated problematic wastes
- One waste stream that has been a focus of the study is graphite that results from construction of Magnox and AGR reactor cores
- Over 76,000m^3 of graphite material currently requires treatment and disposal (UK Radioactive Waste Inventory, 2019) with 60% of this based on Magnox sites
- The baseline method of waste conditioning for graphite wastes has not yet been established. The waste's final destination is expected to be a Geological Disposal Facility, though opportunities are being considered for near-surface disposal



MALLET™ encapsulated Graphite

Problem

- Baseline encapsulation methods using OPC based grouts are problematic, with graphite floatation, the hydrophobic nature of graphite, and activity level limits on mobile radionuclides such as Carbon-14 and Chlorine-36 making graphite difficult to encapsulate and dispose
- Storage of graphite wastes are forecast to cost up to £1,000 per m^3 per year
- Disposal of graphite in a geological disposal facility is forecast to cost up to £50,000 per m^3. Graphite capable of disposal in near-surface facilities would save the UK taxpayer £42,500 per m^3
- Accelerated decommissioning of Magnox reactors will result in graphite wastes arising sooner than previously anticipated, with storage facilities being required sooner for this inventory
- Storage costs for the UK Graphite inventory will exceed £114M per year, with disposal of graphite waste forecast to cost in excess of £4.5Bn
- The hydrophobic nature of graphite in its variety of forms, including blocks and dusts, can result in poor bonding between OPC grouts and the graphite

Solution

- NUVIA and Lucideon MALLET™ geopolymer has been developed, which can be foamed to reduce density and prevent graphite floatation
- Graphite powders can be encapsulated in MALLET™, allowing for crushed graphite and graphite dust to be encapsulated
- MALLET™ forms strong bonds with graphite, and graphite powders can be incorporated directly into the MALLET formulation
- Strong bonding offers the potential of reducing the mobility of particular radionuclides, which could enable near-ground disposal

MALLET™ forms a strong bond with M2 Graphite with no visible cracking present

ACCELERATION OF GRAPHITE DISPOSAL THROUGH MALLET ENCAPSULATION OF GRAPHITE COULD SAVE £114M PER YEAR IN STORAGE COSTS

Benefits

- Lower disposal costs
- Lower interim storage costs
- Lower carbon emissions than OPC
- Simple batch process
- Potential to be used in retrofits of existing encapsulation plants
- Potential to be used as a 'pour on' solution for 3m^3 boxes with graphite blocks
- Enables crushing of graphite as a volume reduction technique
- Has the potential to enable near-ground disposal, at significantly lower cost than geological disposal

An M2 Graphite block was encapsulated with 12% w/w graphite powder, and immersed in deionised water for 7 months, with no cracking or deterioration visible

DIVERTING 30% OF CURRENT ILW GRAPHITE TO NEAR SURFACE DISPOSAL COULD SAVE THE UK TAXPAYER £1.3BN AND SIGNIFICANTLY REDUCE THE SIZE OF A GEOLOGICAL DISPOSAL FACILITY