Andra Call for Projects
with the support of the
Investments for the Future Programme

COCONUT

Composite container for long-term nuclear waste disposal

Project supported by Andra under the "Investments for the Future Programme" ("Investissement d'Avenir") - Selected under the Andra Call for Projects: "Optimisation of post-dismantling radioactive waste management", organised in cooperation with the French National Research Agency (ANR).

Duration: 48 months

Project launch: 01/2017

Total project cost: €1.1 million

Sum covered under the Investments for the Future Programme: €500,000

Type of financial support: Subsidy

Location: Saint-Etienne

Coordinating body: Ecole Nationale d'Ingénieurs de Saint-Etienne (ENISE)

Partners:
- Ecole Nationale d'Ingénieurs de Saint-Etienne (ENISE)
- Ecole Nationale Supérieure des Mines de Saint-Etienne (ENSMSE)

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BACKGROUND

High-level waste (HLW) comprises materials that cannot be recovered following the processing of spent fuel from nuclear power plants. The radioactive elements it contains are now confined in a glass matrix poured into stainless steel drums, which are referred to as "primary packages". After a period of thermal decay in surface storage, these primary packages should themselves be conditioned in disposal containers before ultimately going to the Industrial Centre for Geological Disposal (Cigeo), which is currently being designed. Carbon steel disposal containers have currently been chosen for this purpose. However, corrosion of these metal containers in the conditions within the geological repository (anoxic conditions) can generate significant quantities of hydrogen, a gas which, above a certain quantity, can present a risk of explosion in the presence of oxygen. Alternative conditioning solutions are therefore being studied.

OBJECTIVES AND PROJECT SEQUENCE

The COCONUT project intends to develop an innovative double-shell HLW disposal container concept with an internal steel shell and an external composite copper-ceramic shell, deposited as a thick coating via a cold gas dynamic spraying technique.

It will be carried out over 48 months with 3 primary objectives:

- Master the cold gas spraying process for the two-phase powder mix (copper + ceramic) onto a steel substrate to obtain thick coatings, compatible with the HLW disposal application. Characterisation techniques at different scales (Figure 3) will be implemented to study the durability of the deposits (materials, mechanics, corrosion).

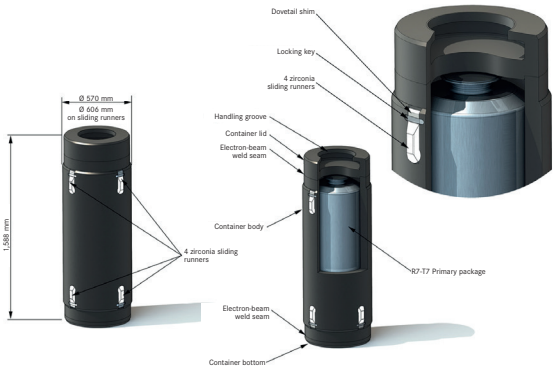

Figure 1: Schematic diagram of a steel disposal package containing a primary package of vitrified waste

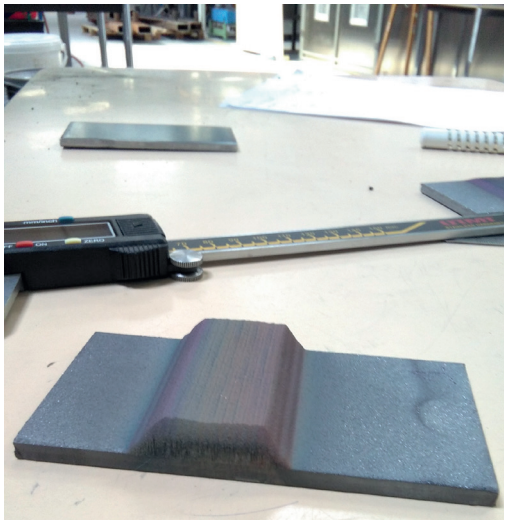

Figure 2: First steel coating tests.
The copper-ceramic deposit is the raised reddish area on the photo

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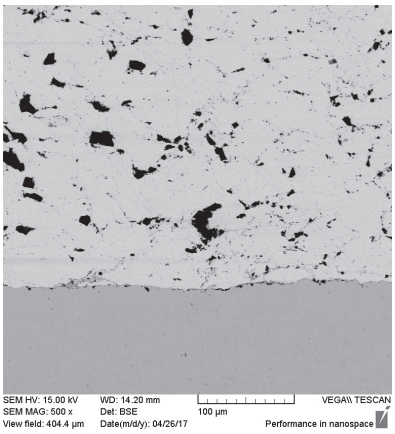

Figure 3: scanning electron microscope image of a metal-ceramic deposit.

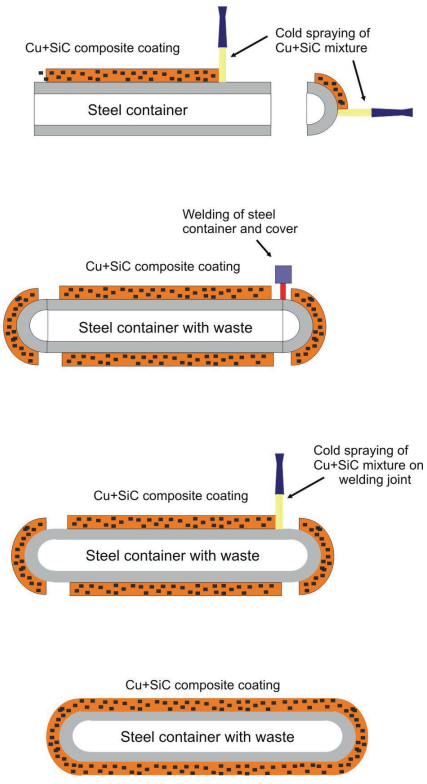

Figure 4: schematic diagram of the metal-ceramic deposition process on the HLW container developed under the COCONUT project

Once the steel process has been validated, the aim will be to demonstrate the feasibility of the metal/ceramic deposition on the weld area (interface between the container body and its cover) in order to ensure continuous deposition on an HLW container.

- Perform a detailed study of the mechanical, physical and chemical behaviour of these coatings in order to optimise their properties.
- Validate this concept by producing a laboratory-scale double-shell container prototype (Figure 4).

EXPECTED RESULTS

Innovation

Capacity to apply thick composite coatings (metal, ceramics) to HLW disposal containers. Development of adapted multi-scale characterisation techniques.
Use of copper/ceramic deposits is a new option for corrosion protection for HLW overpacks. The COCONUT project includes genuine development of original multi-scale characterisation techniques alongside the development of these composite use.

Economic impact

The technical solution proposed can be fairly easily industrialised, and focuses on a niche market with high added value. The use of composite metal/ceramic deposits enables the use of nitrogen as a carrier gas instead of helium, which significantly reduces the production costs for corrosion-resistant deposits.

Impact on radioactive waste management

This project offers an alternative solution to the existing solution. The results are likely to contribute to the development of new long-term disposal concepts for high-level waste.

Social impact

This project will employ two people for three years.

APPLICATION AND COMMERCIALISATION

The main application targeted is HLW disposal. Although this project is more of a fundamental research project, the results could contribute to the launch of a new industrial sector providing metal/ceramic deposits for corrosion protection.