Stability of BORAL in dual purpose canisters – mineral and structural phase changes at elevated repository temperatures

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The U.S. Department of Energy is investigating the use of Dual Purpose canisters for spent nuclear fuel storage as a part of the Used Fuel Disposition Campaign. Such dry spent fuel canisters would be loaded with fuel bundles, and then transported and stored at a nuclear repository. Separating the fuel bundles is a composite thermal neutron absorber (trade name BORAL) consisting of sintered aluminium and boron carbide (B_4C) powders laminated within aluminium metal sheets.

This egg crate structure within the canisters is a vital component to prevent criticality issues.

Although various tests have been performed on BORAL, this material has not been subjected to hydrothermal conditions such as when a canister is breached after emplacement. A scoping experiment reacted BORAL coupons with DI water at 300 °C and 150 bar for 2 weeks.

The aluminium metal was converted primarily to boehmite as: $2Al_{(s)} + 2H_2O = 2AlO(OH)_{(s)} + H_{2(gas)}$.

Over 1700 ml of H_2 gas were generated. The coupons doubled in volume and increased by ~63% in mass. The coupons remained structurally intact, but likely warped due to preferential crystal growth on the Al sheets. Reaction fluids were enriched in aluminium and boron. The reactivity of BORAL at hydrothermal conditions is significant for understanding material stability in a breached canister scenario.