

Hot Corrosion Behavior of Slurry Sprayed Aluminide Coatings in a Simulated Dynamic Molten Carbonate Environment

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One of the key challenges associated with the use of molten salts in Concentrated Solar Power (CSP) plants is to reduce or even suppress corrosion phenomena occurring at elevated temperatures. Molten nitrate mixtures are currently seen as the most viable storage medium for Thermal Energy Storage. But the upper temperature limit of the currently used “Solar Salt” is restricted by salt decomposition at $\sim 580^{\circ}\text{C}$. Prieto *et al.* estimated that increasing the temperature to 650°C could increase the solar-to-electric conversion up to 18.5%, so alternative salts operating at higher temperature are required. Molten carbonates which are less corrosive and allow an operation up to 800°C are an appealing breakthrough for future CSP plants. Protective coatings are envisaged as the most feasible solution to avoid corrosion while maintaining the structural properties of the base material, and should thus be investigated under the new operating conditions. This study is focused on the evaluation of the hot corrosion behavior of two low-cost slurry aluminide coatings with and without Si addition deposited on ferritic-martensitic T91, comparing them with uncoated steel, after 1000-h of exposure to Li, K, Na molten carbonates at 650°C , under dynamic conditions with a high linear velocity (1.3 m/s). Both coatings evidenced a high performance increase in comparison with uncoated T91 and both behaved in a similar way according to the gravimetric results. However, the Si-free aluminide maintained its morphology and composition after 1000 h with $\alpha\text{-LiAlO}_2$ as the only corrosion product while the Si-rich coating showed a higher attack extent in the outer part and developed a large quantity of voids at the coating/substrate interface, allowing substrate corrosion. A small proportion of $\alpha\text{-NaAlO}_2$ was also identified in addition to $\alpha\text{-LiAlO}_2$. In contrast, the uncoated T91 developed a $\sim 150\ \mu\text{m}$ thick multilayered oxide corresponding to $\alpha\text{-LiFeO}_2$ and other Li-Fe oxides on top of a $(\text{Fe,Cr})_3\text{O}_4$ layer. Spallation of the Li-rich external layer took part in some samples. Chemical etching to remove the corrosion products was also undertaken in order to follow the oxidation kinetics by metal loss as a function of time.