Biomass/waste-fired boilers severely suffer from high temperature corrosion of critical load-bearing components, e.g. water-wall and superheater tubes, due to presence of Cl-containing corrosive species. Deposition of a dense and adherent Ni-based coating by high velocity air-fuel (HVAF) thermal spray technique is a promising approach to extend the component's lifetime and, hence, increase the thermal/electrical efficiency of the boilers.

In this research, high temperature corrosion of candidate Ni-based coatings – Ni21Cr, Ni21Cr7AlY, Ni5Al, Ni21Cr9Mo, Ni21Cr9Mo-SiO₂ – sprayed by HVAF has been investigated through detailed laboratory studies in ambient air, moisture and HCl-laden environments. The exposures were conducted at 600 °C for up to 168 h with and without presence of KCl salt. All coatings were highly protective in all environments in the absence of KCl due to formation of corresponding protective scales of alumina or chromia on the coating surface. When KCl was introduced, chromia-forming coatings degraded through a two-stage mechanism; 1) formation of K₂CrO₄ and Cl⁻ followed by diffusion of Cl⁻ through oxide grain boundaries, leading to formation of Cl₂, metal chlorides as well as a non-protective oxide, and 2) inward diffusion of the formed Cl₂ through defects in the non-protective oxide, leading to metal chloride evaporation and breakaway oxidation.

The corrosion behavior of the chromia-forming Ni21Cr coating was improved by addition of alloying elements such as Al and Mo. It was also shown that adding dispersed SiO₂ further increased the corrosion resistance of the coatings. The oxide scale formed in the presence of SiO₂ effectively suppressed Cl⁻ ingress and lowered the corrosion rate, since the formed oxide was continuous, adherent and rich in Cr. The performance of the coatings in the complex Cl-containing environment was ranked as (from highest to lowest corrosion resistance); Ni21Cr9Mo-SiO₂ > Ni21Cr7AlY > Ni5Al > Ni21Cr9Mo > Ni21Cr, confirming the enhanced corrosion protection of chromia-forming coatings in the presence of alloying elements and dispersed SiO₂.