Table 1. HVAF process parameters used to spray the NiCrMo and NiCrMo-SiO_2 coatings

Variables	
Nozzle type	4L2G
Air pressure, MPa	0.8
Fuel 1 pressure-Propane, MPa	0.7
Fuel 2 pressure-Propane, MPa	0.7
Carrier gas pressure-N_2, MPa	0.4
Feed rate, g/min	150
Pass velocity, m/min	50
Pass spacing, mm/rev.	5
Spray distance, mm	300
Number of Passes	8

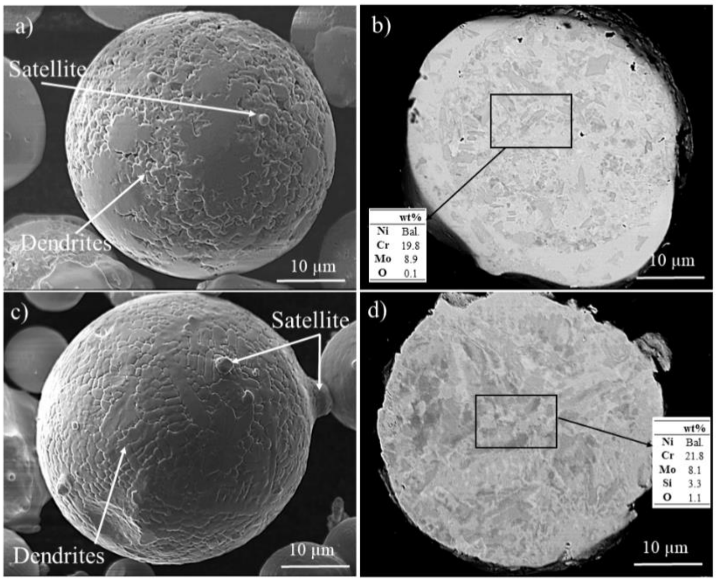


Fig. 1. SEM topographic (SE mode) and cross-section (BSE mode) of; a, b) NiCrMo and c, d) NiCrMo-SiO_2 powders, and the corresponding EDS analysis.

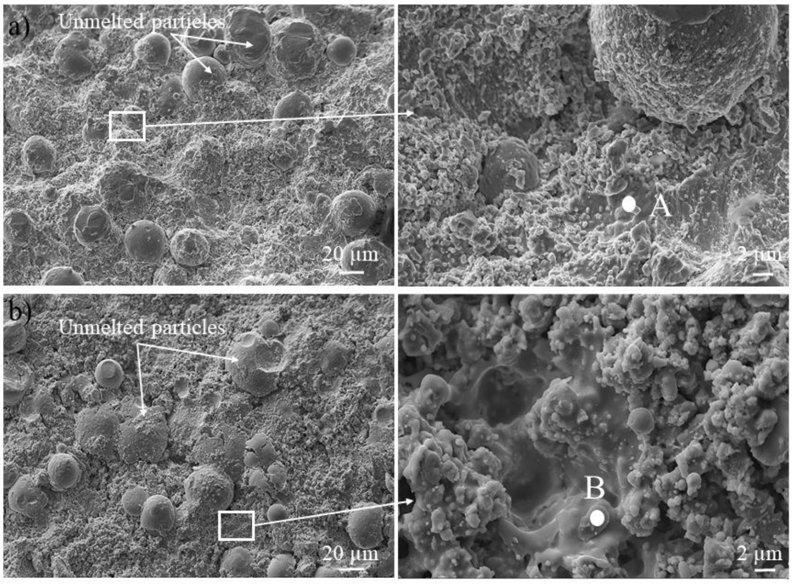
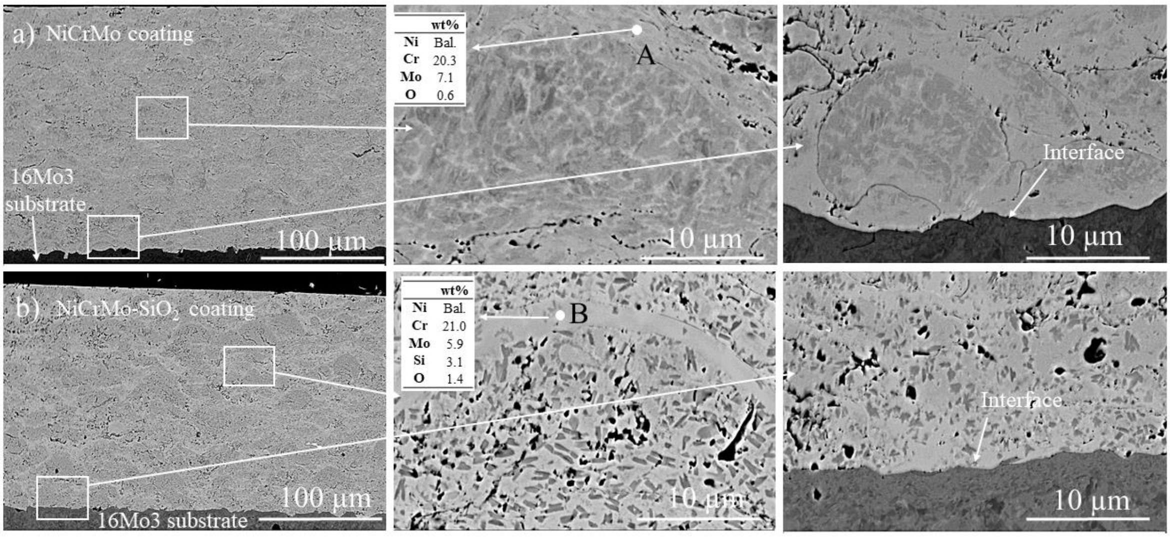


Fig. 2. Topographical SEM micrographs (SE mode) of the as-sprayed a) NiCrMo, and b) NiCrMo-SiO_2 coatings.



	wt%
Ni	Bal.
Cr	20.3
Mo	7.1
O	0.6

	wt%
Ni	Bal.
Cr	21.0
Mo	5.9
Si	3.1
O	1.4

Fig. 3. SEM micrographs (BSE mode) of cross-sections of the polished coatings, coating/substrate interfaces, and EDS point analysis, a) NiCrMo, and b) NiCrMo-SiO_2.

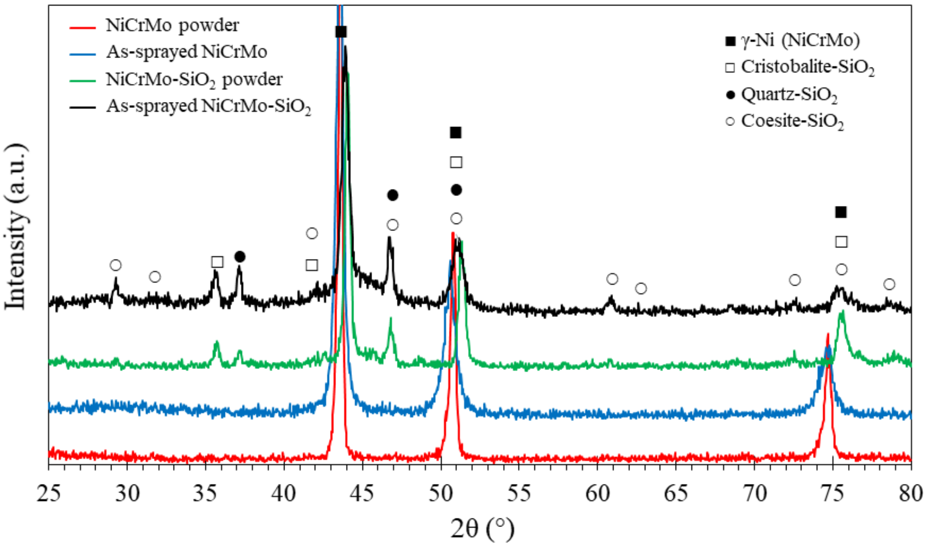


Fig. 4. XRD patterns of the feedstock powders and corresponding polished NiCrMo and NiCrMo-SiO$_2$ coatings.

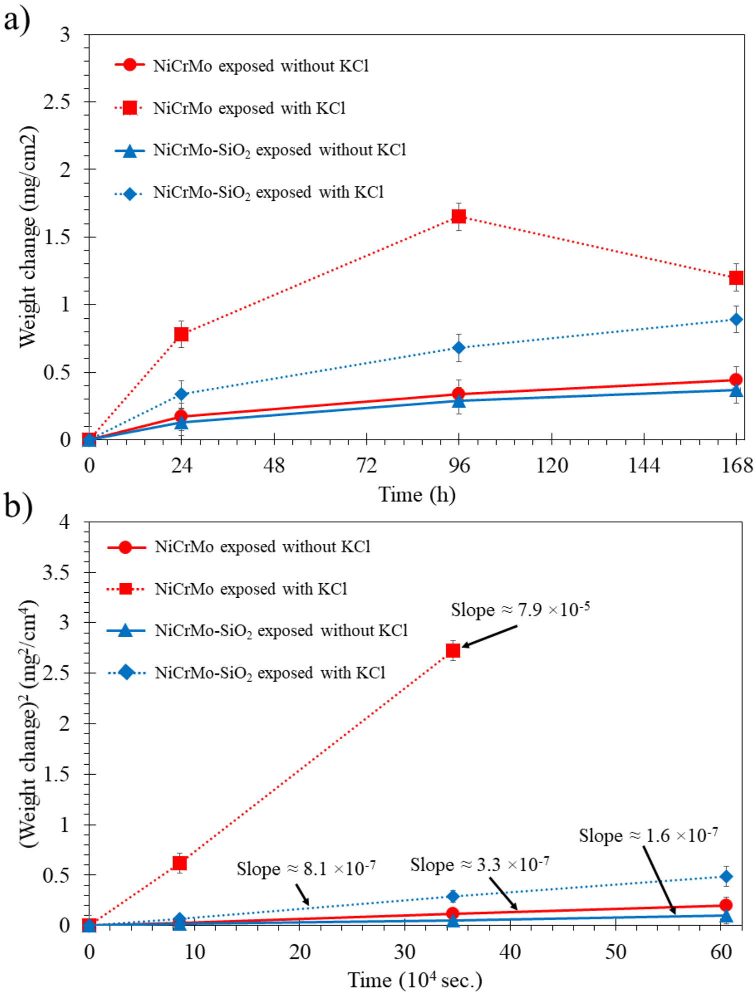


Fig. 5. a) weight change of the exposed NiCrMo and NiCrMo-SiO$_2$ coatings in 5%O$_2$ + 500 ppm HCl + N$_2$ with and without KCl deposit for up to 168 h at 600 °C, and b) squared of weight gain versus time (sec.). k_p value for NiCrMo exposed to KCl was measured within the exposure period from 0 to 96 h to avoid the interference by the weight change drop observed from 96 to 168 h.

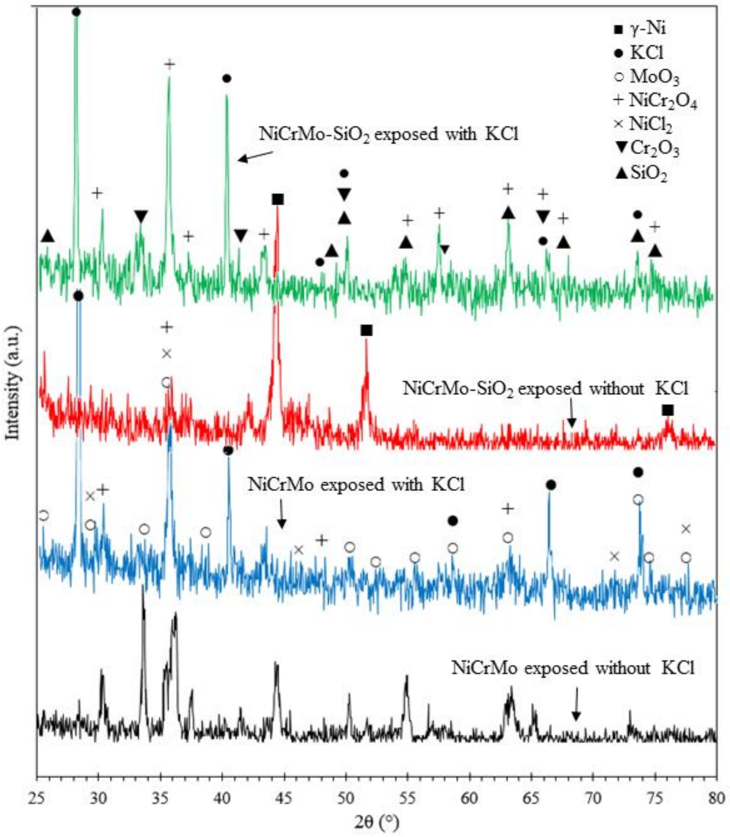


Fig. 6. XRD patterns of the exposed NiCrMo and NiCrMo-SiO$_2$ coatings in 5%O$_2$ + 500 ppm HCl + N$_2$ with and without KCl deposit up to 168 h at 600 °C.

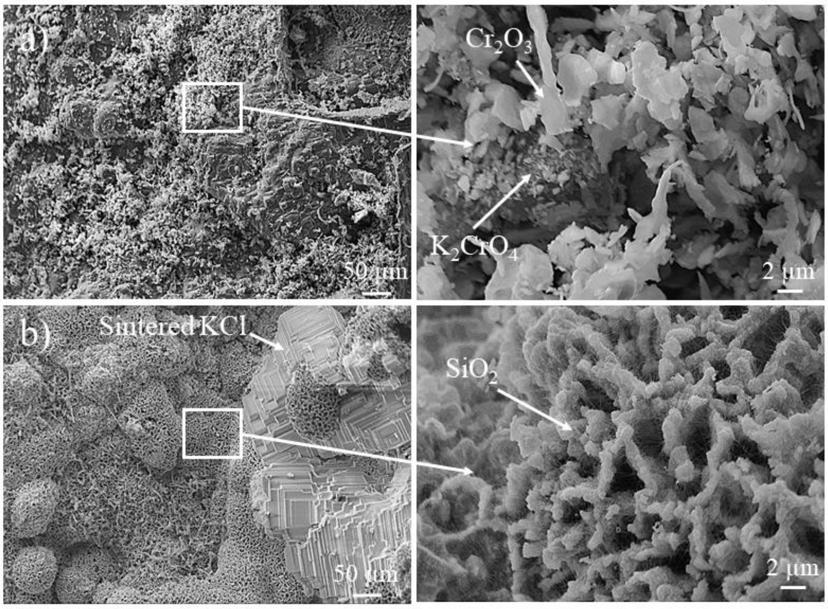


Fig. 7. SEM topographic micrographs (SE mode) of the coatings exposed in 5%O$_2$ + 500 ppm HCl + N$_2$ with KCl for 168 h at 600 °C a) NiCrMo and, b) NiCrMo-SiO$_2$.

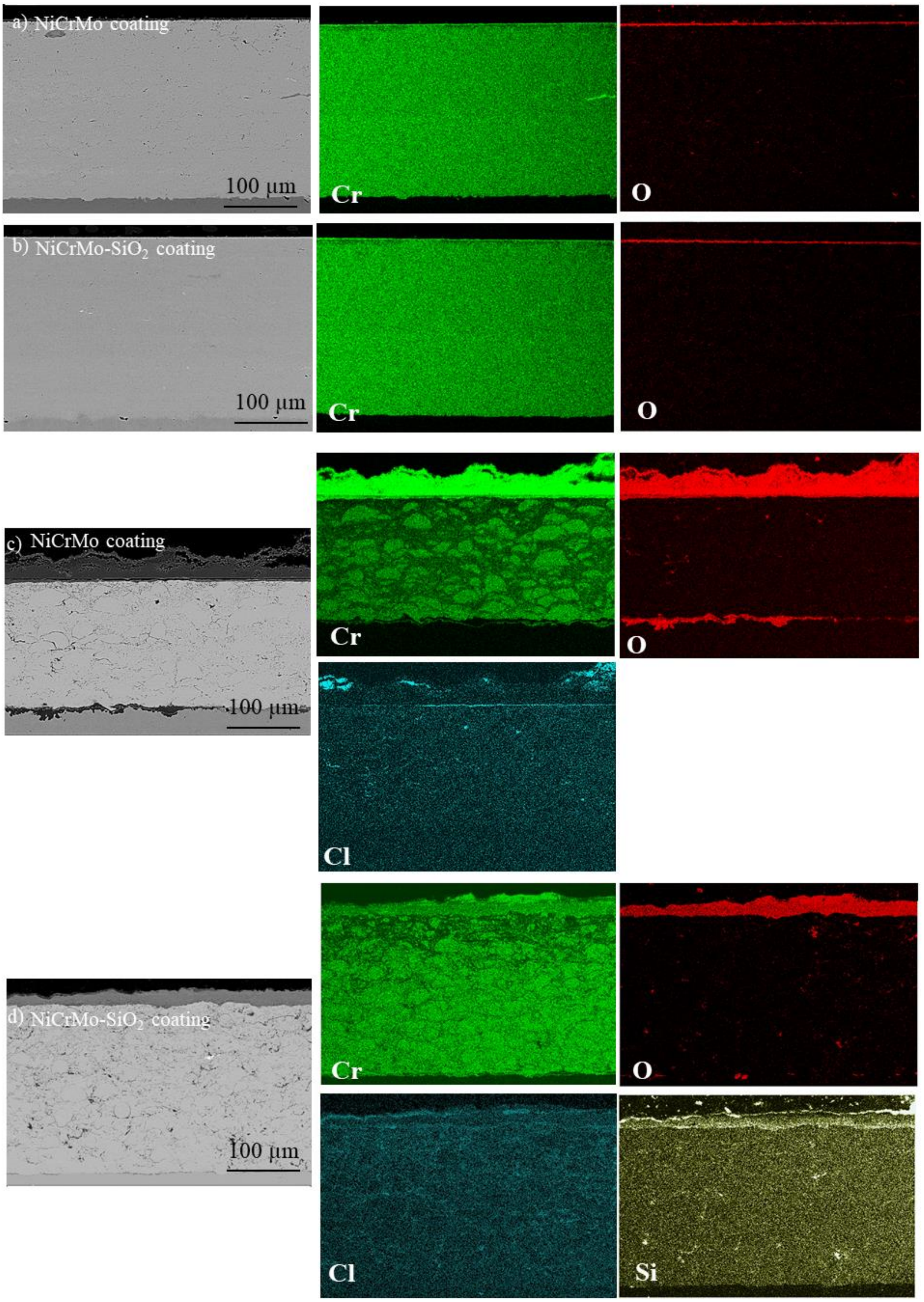


Fig. 8. Back-scattered SEM micrographs of cross-sections of the exposed coating in 5%O_2 + 500 ppm HCl + N_2 for 168 h at 600 °C, a) NiCrMo exposed without KCl, b) NiCrMo exposed with KCl, c) NiCrMo-SiO_2 exposed without KCl, and d) NiCrMo-SiO_2 exposed with KCl.

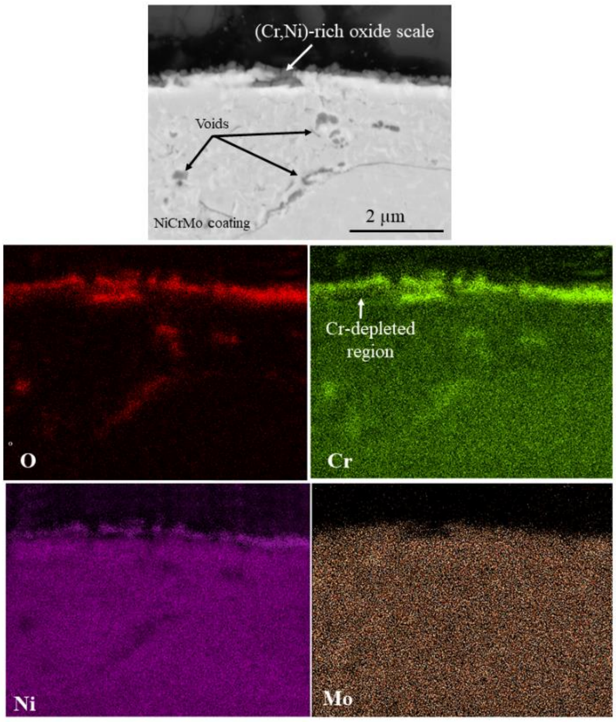


Fig. 9. Back-scattered SEM micrographs of cross-sections of the exposed NiCrMo coating in 5%O_2 + 500 ppm HCl + N_2 without KCl deposit for 168 h at 600 °C.

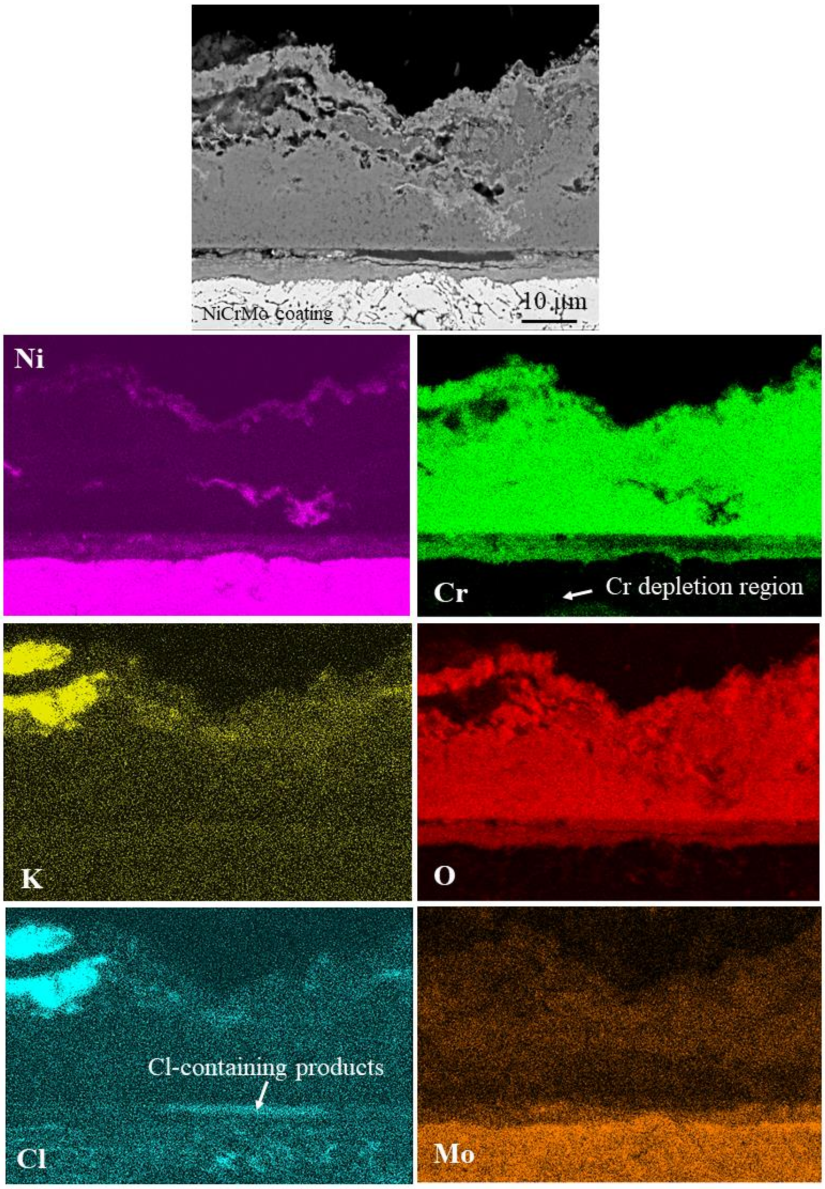
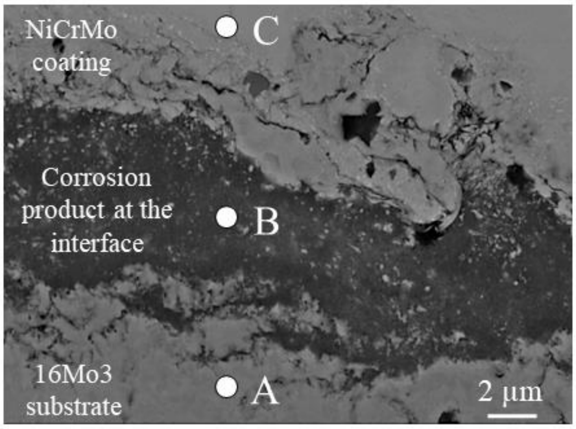


Fig. 10. Back-scattered SEM micrographs of cross-sections of the exposed NiCrMo coating in 5%O_2 + 500 ppm HCl + N_2 with KCl deposit for 168 h at 600 °C.



Spectrum	Chemical composition (wt%)					
	O	Cl	Cr	Fe	Ni	Mo
A	0.7	0.04	0.6	Bal.	0.2	-
B	21.6	0.7	2.9	Bal.	8.0	-
C	2.5	0.4	17.0	2.5	Bal.	4.9

Fig. 11. Back-scattered SEM micrograph of the NiCrMo coating/substrate exposed in 5%O_2 + 500 ppm HCl + N_2 with KCl deposit for 168 h at 600 °C, and the corresponding EDS analysis, point A at the substrate, point B at the coating/substrate interface and point C at the coating.

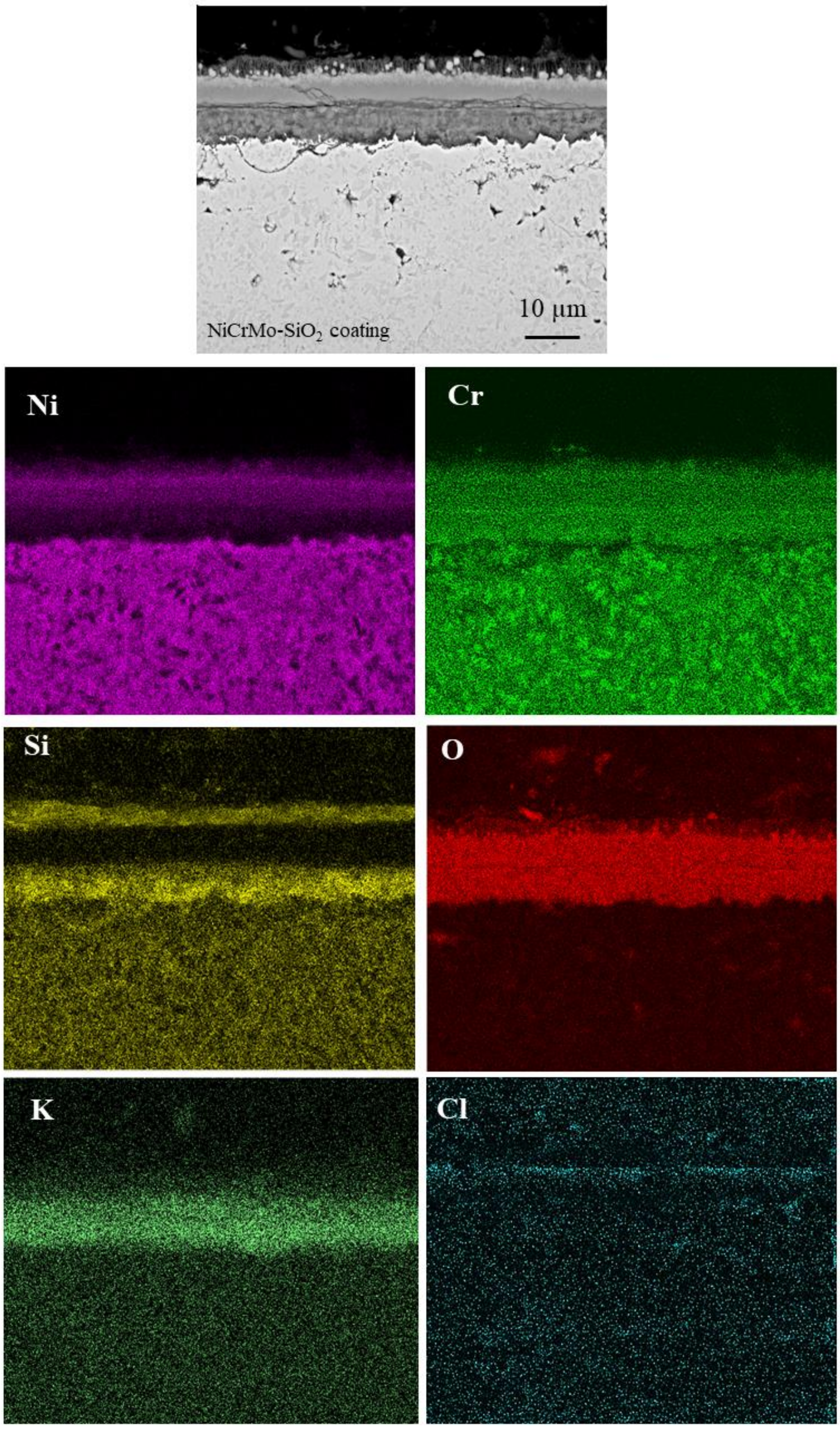


Fig. 12. Back-scattered SEM micrographs of cross-sections of the exposed NiCrMo-SiO$_2$ coating in 5%O$_2$ + 500 ppm HCl + N$_2$ without KCl deposit for 168 h at 600 °C.

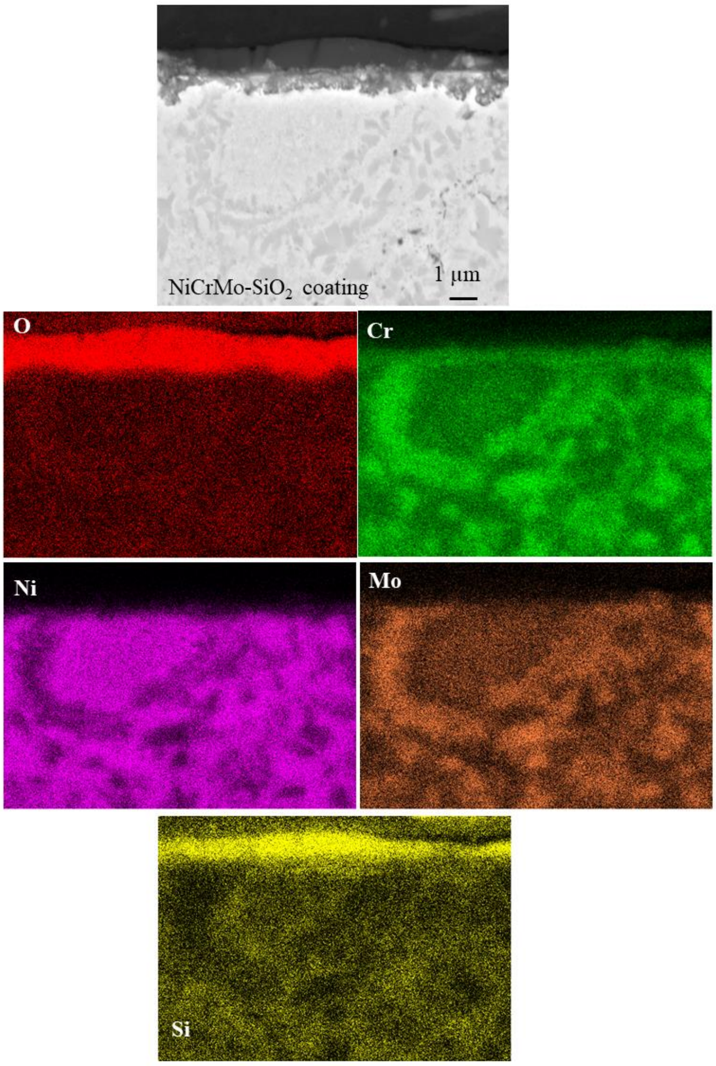


Fig. 13. Back-scattered SEM micrographs of cross-sections of the exposed NiCrMo-SiO$_2$ coating in 5%O$_2$ + 500 ppm HCl + N$_2$ with KCl deposit for 168 h at 600 °C.

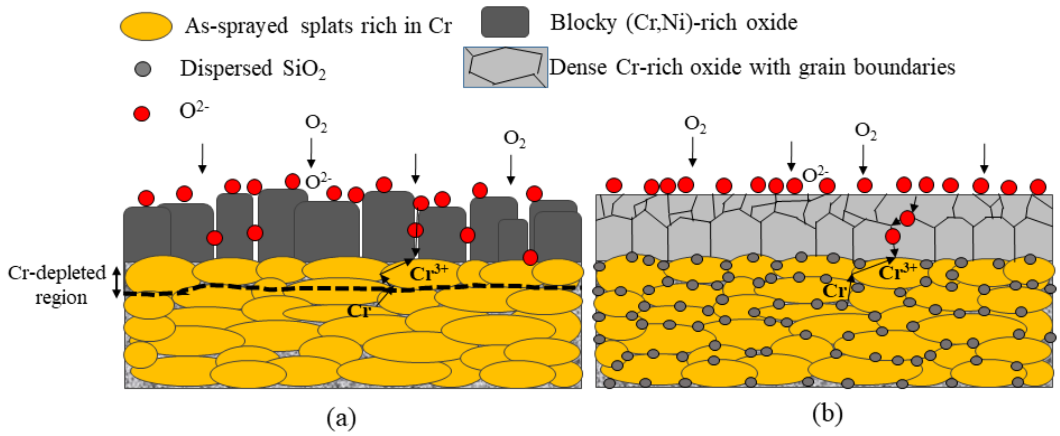


Fig. 14. Schematic of corrosion mechanism in the coatings exposed into 5%O$_2$ + 500 ppm HCl + N$_2$ for 168 h at 600 °C without KCl deposit, a) NiCrMo, and b) NiCrMo-SiO$_2$. SiO$_2$ promoted the selective oxidation of Cr to form the protective

Cr-rich oxide scale on NiCrMo-SiO_2. While a (Cr,Ni)-rich oxide formed on NiCrMo, a dense Cr-rich scale formed on NiCrMo-SiO_2.

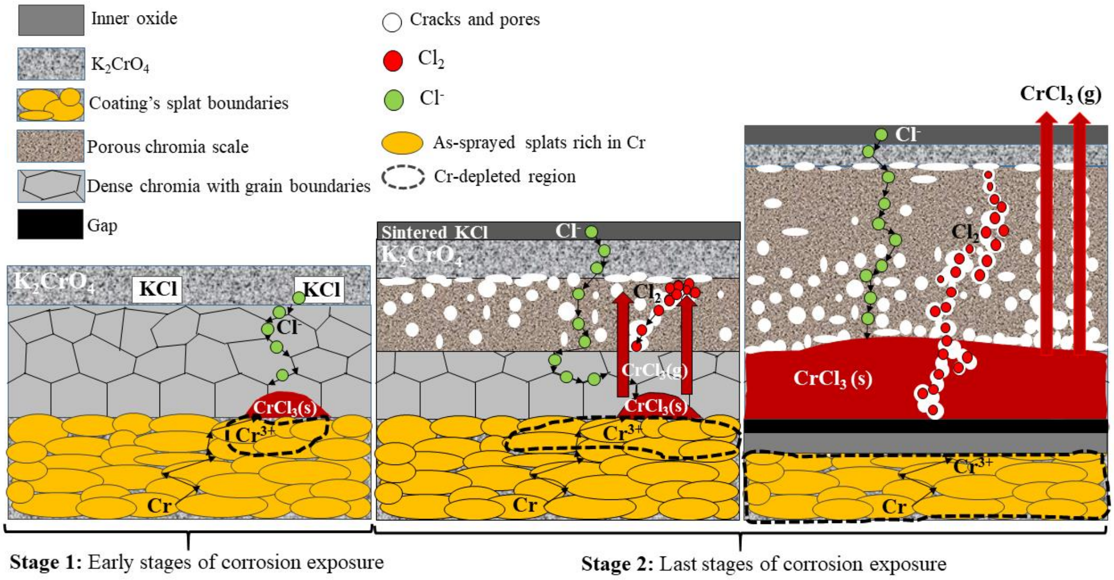


Fig. 15. Schematic of corrosion mechanism in the NiCrMo coating exposed into 5%O_2 + 500 ppm HCl + N_2 with KCl deposit for 168 h at 600 °C. At the early stages, the corrosion is initiated by the formation of K_2CrO_4 and Cl^-. K_2CrO_4 depletes the oxide scale in Cr leading to a loss of the protective properties of Cr_2O_3. The metallic chlorides and Cl_2 form in this stage. In the second step, the formed Cl_2 diffuses inward through the defects (cracks and pores) of the non-protectives oxide scale formed in the previous step. Cl^- and Cl_2 diffuse through the oxide grain boundaries ("electrochemical" mechanism) and oxide's defects ("active-corrosion" mechanism) respectively to reach the coating/oxide scale interface. Vaporization of the metallic chlorides occurs in this step, which leads to formation of the gap at the coating/chloride layer [45].

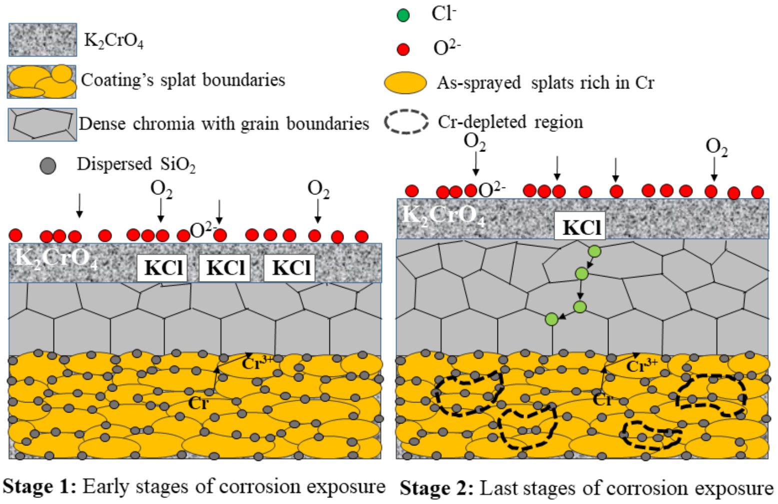


Fig. 16. Schematic of corrosion mechanism in the NiCrMo-SiO_2 coating exposed into 5%O_2 + 500 ppm HCl + N_2 with KCl deposit for 168 h at 600 °C. The dispersoids decelerated formation of Cl^- and K_2CrO_4 at the early stages. Random diffusion of Cl^- within the oxide layer and a few Cr-depleted regions within the coating were observed; however, in general, the

dispersoids succeeded to protect the coating and accordingly the substrate by promoting formation of a dense and protective Cr-rich oxide scale.