Oxidation Behavior Studies of $Mn_{1.5}Co_{1.5}O_4$-Coated and Uncoated Low-Chromium Alloys as Solid Oxide Fuel Cell Interconnects (SOFC)

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Introduction

Ferritic stainless steel alloys have a combination of good oxidation resistance and appropriate coefficient of thermal expansion that makes them attractive for use as interconnect in SOFC. However, Cr in ferritic alloys can lead to poisoning of the cathode, so ceramic coatings are applied to reduce chromium volatilization. With the use of coatings, alloys with lower chromium contents could potentially be used.

Experiments

➢The dual oxidation behaviors of uncoated ferritic alloys with different Cr concentrations.

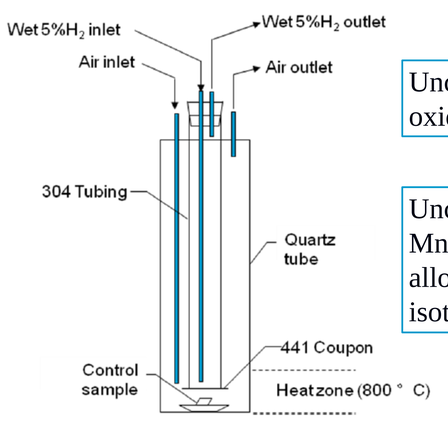
➢Cyclic and isothermal oxidation behavior of $Mn_{1.5}Co_{1.5}O_4$-coated alloys with different Cr concentrations.

Material compositions

Element (wt%)	Cr	C	Mn	Si	Ti	Nb	Fe
H52	13.047	0.018	0.290	0.345	0.187	0.348	Balance
H53	15.057	0.021	0.297	0.352	0.203	0.347	Balance
H54	16.878	0.020	0.305	0.365	0.237	0.366	Balance
H55	17.820	0.021	0.303	0.347	0.222	0.360	Balance

Experimental procedure

Dual experiment setup



Uncoated alloys dual oxidation

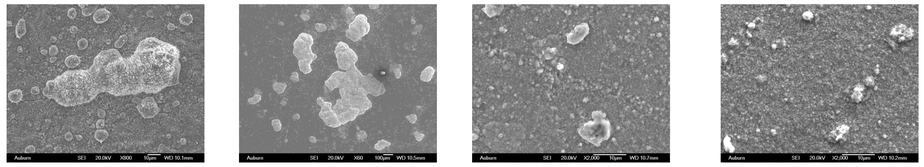
- XRD analysis
- Surface SEM &. EDS microstructure analysis

Uncoated and $Mn_{1.5}Co_{1.5}O_4$-coated alloys cyclic and isothermal oxidation

- Cross section SEM &. EDS microstructure analysis

Results

Uncoated alloys: Dual oxidation



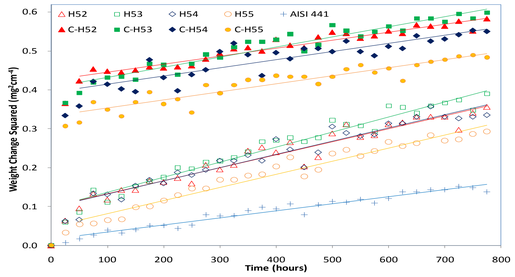
H52 H53 H54 H55

Oxide scale surface microstructure of H samples' air side after Dual oxidation 800ºC-200hrs

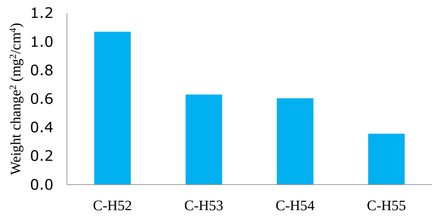
(Air side: 35ml/min dry ¦5% H_2 side: 35ml/min wet)

The above images show the surface oxide scale microstructure on the air side after dual oxidation. H52 showed many Fe_2O_3 nodules. H53 only had a small area of Fe_2O_3 nodules. The oxide scale of H54 and H55 are composed of surface $(Cr,Mn)_3O_4$ spinel phase and Cr_2O_3 sublayer, and no Fe_2O_3 nodules were found.

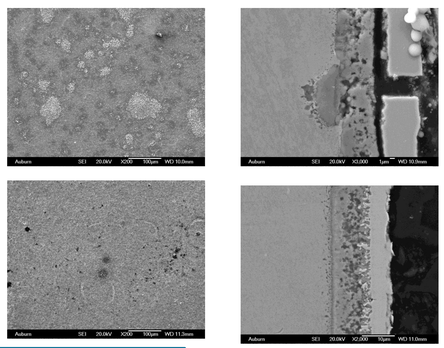
$Mn_{1.5}Co_{1.5}O_4$ -coated alloys: Isothermal and cycle oxidation



Weight change square after 800 ℃-800hr cycle oxidation (25hr interval)



Weight change square after 800 ℃-800hr isothermal oxidation



Coated H52 after 800 ℃-1600hr isothermal oxidation: Spallation of oxide scale was found. Cross section microstructure showed thicker oxide scale in some areas.

Coated H55 after 800 ℃-1600hr isothermal oxidation: No spallation was found on the surface of the coating.

Conclusion

➢Samples with higher Cr concentration showed better dual oxidation resistance.

➢Cyclic and isothermal oxidation studies of $Mn_{1.5}Co_{1.5}O_4$-coated alloys found that higher Cr concentration leads to better adherence of coating to the substrate alloys.

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