

## The Formation of Oxide Scale on FeCrAl in dry O<sub>2</sub> and O<sub>2</sub> + 40% H<sub>2</sub>O

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FeCrAl alloys containing different reactive elements are used in many high temperature applications where oxidation resistance is an issue, for example in industrial furnaces. The excellent oxidation resistance depends on the formation of a protective layer of  $\alpha$ -Al<sub>2</sub>O<sub>3</sub>. In some cases, for example in automotive catalyst supports, FeCrAl alloys are exposed to environments containing high concentrations of water vapour.

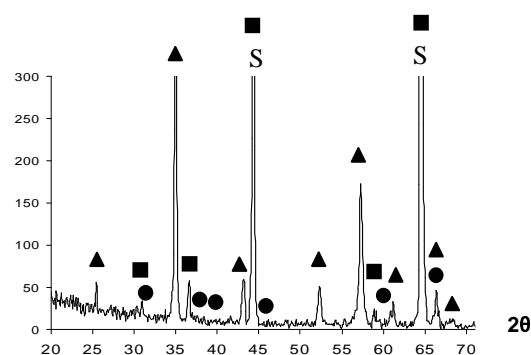
The present work investigates the influence of adding water vapour to oxygen on the formation of a protective oxide scale on Kanthal AF at 900°C. Especially, we investigate the effect of gas composition on oxide morphology and chemical composition.

Isothermal exposures were performed at 900°C with a precise control of flow conditions, temperature and gas composition. The gas atmosphere was dry oxygen or oxygen containing 40% water vapour. The samples were exposed between 1 and 336h in a horizontal tube furnace. Additional exposures <72 hours were carried out in a thermobalance. The samples were investigated by a number of surface analytical techniques including grazing angle XRD, SEM/EDX, FIB, TEM/EDX and AES.

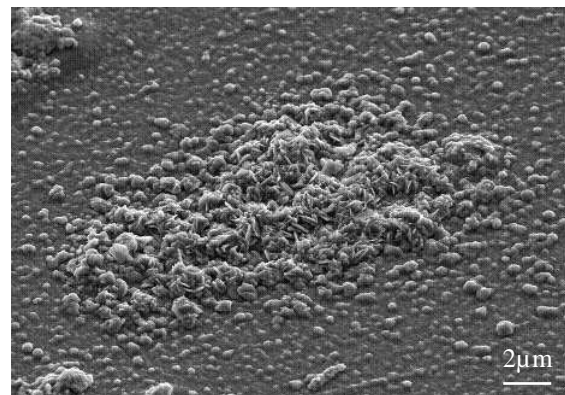
XRD showed that  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> was a major constituent in the oxide scale at all exposure times and in all environments studied. In addition, MgAl<sub>2</sub>O<sub>4</sub> was identified together with  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> (Fig. 1). In accordance with the identification of MgAl spinel, Auger analysis showed that the outermost part of the oxide scale quickly becomes enriched in magnesium.

The oxide scale consists of a thin smooth oxide (base oxide) together with different larger oxide particles. The oxide thickness after 1h is about 200 nm and the base oxide is smooth. After 336h the oxide scale thickness is about 1  $\mu$ m and the base oxide is relatively rough and consists of equiaxed and blade like grains.

While water vapour has negligible effect on oxide thickness under these experimental conditions, it does affect morphology. In dry oxygen, large (10 $\mu$ m) areas of agglomerated needle like oxide particles were commonly observed, see Fig. 2. These agglomerates could not be seen when water vapour was present. In addition, in the wet (but not in the dry) atmosphere, round oxide particles with a typical size of some micrometers were present.



**Fig. 1.** GI-XRD of a specimen exposed 168h in O<sub>2</sub>. The symbols indicate:  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> (▲),  $\gamma$ -Al<sub>2</sub>O<sub>3</sub> (●), MgAl<sub>2</sub>O<sub>4</sub> (■) and substrate (S).



**Fig. 2.** SEM image of an area of agglomerated needle like oxide particles on a specimen oxidized at 900°C in O<sub>2</sub> during 24h.