Growth Stresses and Texture of Nano-structured Oxide Layers Growing on Iron Aluminides

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Iron aluminides are important materials for high temperature applications because of their ability to form an adherent α-Al_2O_3 scale on the metal surface that protects it from against destructive oxidation and corrosion. Critical factors affecting the oxidation resistance of these alloys are growth stresses intrinsic to the oxidation process and the residual stresses that result after cooling down to room temperature.

The aim of the present work is to determine the evolution of growth stresses developed within the oxide scale grown on different Fe-Al alloys. Single crystals and polycrystals of Fe-15at.%Al and Fe-26at.%Al were used in the investigations. Stress and texture analyses were performed using synchrotron x-ray diffraction. The chemical composition of the scales was determined using x-ray photoelectron spectroscopy.

After 5h of oxidation at 700°C oxide scales of approximately 100nm thickness develop. Chemical composition analyses reveal a multi-layered oxide scale composed of α-Al_2O_3 and α-Fe_2O_3. Texture analyses showed that the α-Al_2O_3 grains grow preferentially in the (0001) direction and also suggest a correlation between the orientation of the α-Al_2O_3 and α-Fe_2O_3. In-situ stress analyses showed that α-Al_2O_3 develops compressive stresses throughout the entire oxidation process. The growth stress behavior is governed by the epitaxy between α-Al_2O_3 and α-Fe_2O_3.