Influence of a chromium layer on the high temperature reactivity of chromino-former austenitic and ferritic stainless steels: Chemical, microstructural and mechanical study of oxide layers

Mohammed ALLAM

Supervisor: Valérie Parry

Wednesday, December 1st 2021 – 2:00 p.m.

Amphi Jean Besson (Phelma Campus)

Jury :
Monsieur Bruno GILLES, DIRECTEUR DE RECHERCHE, CNRS, Président
Monsieur Jean-Luc GROSSEAU-POUSSARD, PROFESSEUR, Université de La Rochelle, Rapporteur
Monsieur Benoit PANICAUD, PROFESSEUR, Université de Technologie Troyes, Rapporteur
Madame Ioana POPA, MAITRE DE CONFERENCES, Université de Bourgogne, Examinatrice

Abstract: The present work aims to study and improve chemical and mecanical durability at high temperature of iron based alloys. For this, oxidation tests were performed at 850 °C for duration varying between few minutes to more than 1000 h on austenitic and ferritic stainless steels with or without a chromium film (100 nm) deposited by PVD.

Without Chromium deposition on surface, microstructural characterizations showed that austenitic steels and ferritic steels with low Cr content are susceptible to breakaway oxidation characterized by the formation of unprotective iron oxides. While in the presence of the Chromium film the thermally grown oxide has a duplex morphology ($MnCr_2O_4$ /Cr_2O_3) with a protective character even in the long term (max duration tested 2000 h). The kinetics study demonstrate that the oxidation rates are slower in the presence of the Chromium thin layer on austenitic and ferretic stainless steel surface.

The thin microstructurals characterizations (ACOM-TEM) alloed to understand the contribution of Chromium film on the nature of formed oxides on stainless steels during the first stages of oxidation. A growth mechanism has been proposed. Finally, micro-mecanical tests devoted to adherance caracterization (bulge-blister inversed) have been performed in order to quantify oxide layers and showed a beneficial effect of chromium deposition on the adhesion of the oxide layers grown on austenitic steels.