4th International Symposium on
Energy Challenges & Mechanics
- working on small scales

11-13 August 2015
Aberdeen, Scotland, UK

In situ high temperature corrosion analysis of metals using acoustic emission coupled with thermogravimetry

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Accepted for publication on 19th March 2015

High temperature corrosion of metallic alloys (like Iron, nickel, cobalt alloys) can damage equipment of many industrial domains (refinery, petrochemical …). Acoustic emission (AE) is an interesting method owing to its sensitivity and its non-destructive aspect to quantify the level of damage in service of these alloys under various environmental conditions. High temperature corrosive phenomena create stresses in the materials; the relaxation by cracks of these stresses produces transient elastic waves which can be recorded and analyzed using the AE system. In case of high temperature environments, a waveguide may be used to transmit waves from the sample to the sensors. For this purpose, thermogravimetric analysis (TGA) has been coupled with acoustic emission (AE). Simultaneous measurements of the mass variation and of the acoustic signals emitted during the corrosion of samples at high temperature provide complementary information. For this purpose a specific alumina waveguide (WG) has been developed. The oxidation of a zirconium alloy was firstly studied to validate the waveguide operation at 900 C.

Metal dusting represents a severe form of corrosive degradation of metal alloy. *In situ* iron metal dusting corrosion, with or without pre-oxidized layer, was studied using EA coupled with TGA at 650°C under an industrial atmosphere: i-C_4H_{10} + H_2 + He. Acoustic emission signals were detected after a significant increase of the sample mass (carbon deposit). AE numerical treatments completed by SEM observations of the corroded samples allow us to propose a corrosion mechanism.

From this innovative study we can conclude that thermogravimetric experiments coupled with acoustic emission analysis are of interest in improving understanding of metallic material corrosion at high temperature. AE analysis is complementary for *post-mortem* oxidized sample characterizations.

Keywords: Corrosion, Thermogravimetry, Acoustic emission