Corrosion of alloys at high temperatures – Synergies between experiment and thermodynamic modelling using ChemApp

M. Auinger

WMG, University of Warwick, England

Steels and other corrosion resistant alloys for high temperature applications are an important backbone for modern applications, such as for the automotive and aerospace sector as well as for boilers and waste incineration plants. Due to this, such alloys have gained great importance in modern energy politics. The need for even stronger, yet formable, materials is of particular importance for the automotive sector, where lightweighting opportunities are sought to significantly reduce the fuel consumption of vehicles, thus meeting the strict carbon dioxide emission criteria.

High strength steels in automotive, such as TRIP steels, often contain significant amounts of manganese. During and after hot-rolling, which is a quick and effective method for the size reduction from a thick slab to a thin sheet, the alloy suffers from oxidation. Whereas the external oxidation (mostly formation of wustite and magnetite) occurs rather quickly, internal oxidation of the alloying elements such as Al, Cr, Si, Mn can lead to significant changes of the product quality.

Internal oxidation is a process, driven by the local oxygen activity in the material and the element transport near the metal / wustite interface. Under typical process conditions for steel coiling and coil cooling, this can lead to internal oxides, ranging up to 20 µm into the material. Although this number may not sound too large on an absolute scale, it already represents 4% of a 1mm thick sheet material. Especially when internal oxides are present at grain boundaries, this may lead to severe crevice corrosion in subsequent pickling lines or weaken the cohesion between individual grains, which may ultimately fall off during forming.

It is thus the aim of this presentation to shine light on some mysteries of high temperature oxidation (modelling) of these alloys by combining transport modelling and thermodynamic stability of oxide phases by linking ChemApp with other programmes. Obtained results are compared to experimental studies on binary and ternary model alloys.