Investigation of dry corrosion performance in multi-component alloys using CSAFs.

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Superalloys are used in various fields and in harsh environments for their corrosion resistance properties superior to those of common structural materials. However, when exposed to extremes and corrosive atmospheres, these alloys do suffer from corrosion. Controlling and minimizing the oxidation of multicomponent metal alloys relies on understanding of the corrosion mechanism and the methods or approaches to their passivation.[1-3] As the composition of alloys is generally a critical degree of freedom in reducing the extent of corrosion, it is often necessary to conduct studies on many different compositions of a given alloy type, in order to maximize corrosion resistance. This can be an arduous task; however, high throughput methodologies using materials libraries or composition spread alloy films (CSAFs, Fig.[5]) seem to be an ideal way to acquire fundamental knowledge about these systems spanning composition space.[4] Herein, we report the study of $Fe_xNi_yCr_{1-x-y}$ superalloy CSAFs (~100 nm thick), alloys prepared such that a single 14×14 mm Mo substrate is covered with a $Fe_xNi_yCr_{1-x-y}$ thin film with a lateral composition gradient that spans the entire composition space, x = 0 → 1 and y = 0 → 1-x. Energy dispersive X-ray analysis (EDX) has been used to estimate the thickness of the deposited film and to map the bulk composition of the film across the CSAF sample. These materials libraries were then exposed to a corrosive atmosphere consisting of dry air at temperatures of T = 300-773 K for periods of 1 hr. Optical imaging was sufficient to reveal significant differences in the alloy corrosion over different regions of composition space. X-ray Photoelectron Spectroscopy (XPS) analyses combined with Ar^+ etching (depth profiling) yield insight into the composition dependence of the corrosion mechanism and its passivation; all obtained by studying one sample. For example we have been able to determine the critical chromium composition above which the alloy is passivated against bulk corrosion, N_{Cr}*(x,y), mapped across alloy composition space. The presentation will highlight the high throughput methodology used in this study, illustrate its strengths compared to traditional methodologies, and mention some of its limitations. In summary, we demonstrate that these new tools enable the creation of datasets that are otherwise inaccessible. These offer new insight into the science of alloy corrosion and the engineering of alloy materials for corrosion passivation.

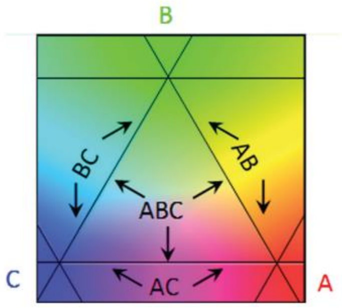

Fig 1: Schematic representation of a ternary composition spread alloy film ABC [5]

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