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# Surface states of chromium-rich HfC-containing Co-based, Ni-based and Fe-based alloys after oxidation at 1000 and 1100°C

Patrice Berthod, Elodie Conrath

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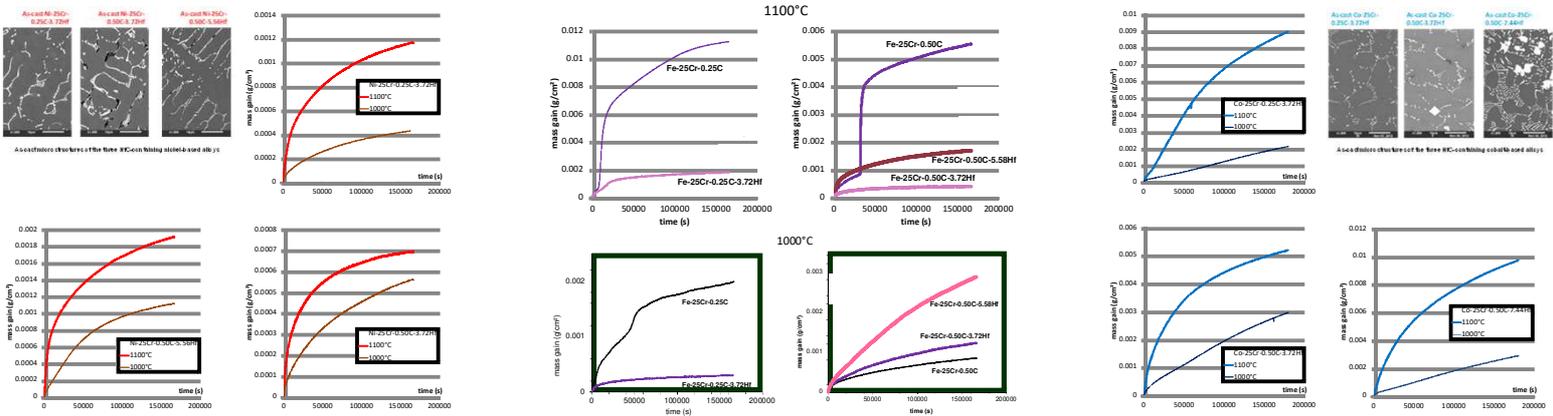
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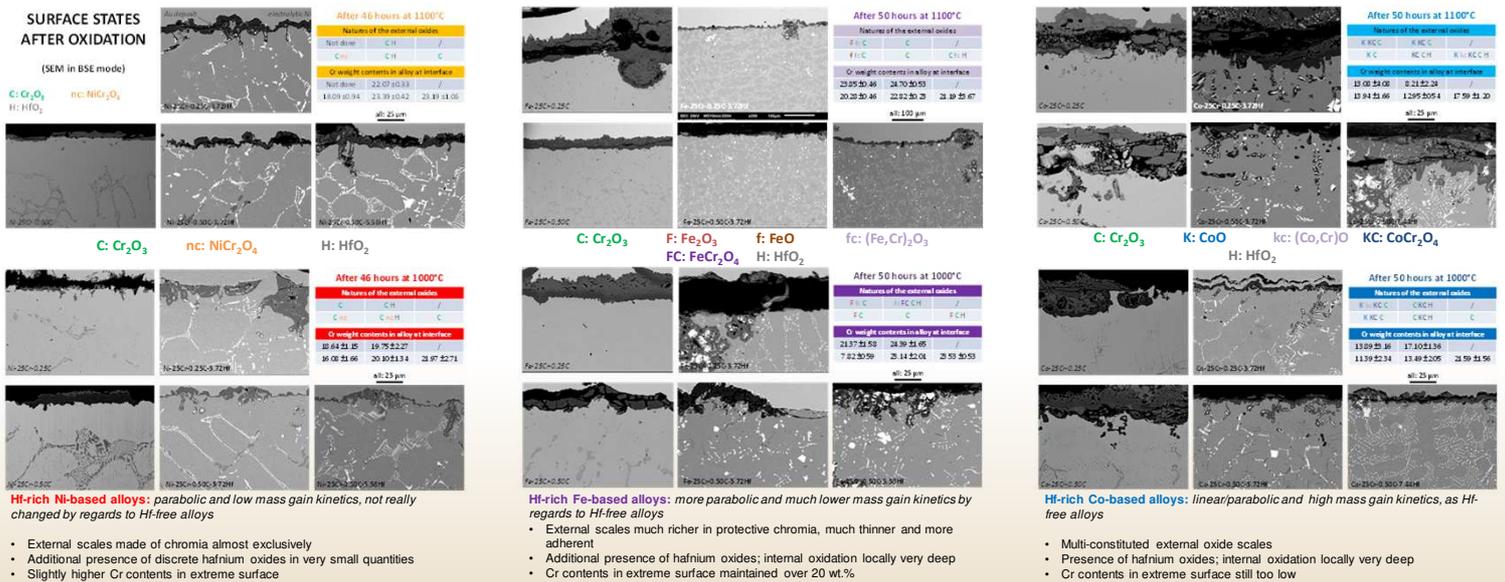
Some of the metallic alloys designed for high temperature applications are reinforced by carbides, especially the equiaxed ones elaborated by foundry. This is notably the case of many cobalt-based alloys but several nickel-based or iron-based alloys are also concerned. The presence of carbides, especially the interdendritic ones appeared at the end of solidification, may greatly influence the behaviour in oxidation at high temperature of the alloys. The knowledge about the effect of chromium carbides and of some of the other ones, for example tantalum carbides, is rather complete. In contrast, other MC carbides a little more exotic (such as hafnium carbides) can be considered for strengthening the alloys to achieve mechanical resistance high enough for increased temperatures of service. In the case of the hafnium carbides, the high contents in hafnium compulsory to develop significant HfC networks let think that consequences of these Hf quantities maybe expected on the high temperature oxidation behaviour of these alloys.

There were previously many thermogravimetric characterization of the oxidation kinetic at 1,000 and 1,100°C of cobalt-based [2], nickel-based [2] and iron-based alloys [3], all containing 25wt.%Cr, and 3.7 to 7.4wt.%Hf for 0.25 to 0.50wt.%C. The values of the parabolic constants (and chromia volatilization constants when relevant) were then specified and commented. The purpose of this work is to show now the results of post-mortem characterization of the oxidized samples.

## Mass gain kinetics [2, 3]



## Metallography results



The differences formerly observed in the mass gain kinetics are globally explained by the post-mortem characterizations. The high amounts in Hf do not seem neither improve nor threaten the high temperature oxidation of the Ni-25Cr-C alloys. A global improvement is seen in the case of the Fe-25Cr-C alloys while, in contrast, the behaviour of the Co-25Cr-C alloys is as bad as in absence of hafnium. Deeper in the bulk the hafnium carbides well behaved in volume fraction and morphology stability, which allows benefiting on the good creep resistances brought by these carbides (encouraging first results, on-going work). The HfC-containing alloys based on Ni or on Fe can be considered as ready to be used for applications at elevated temperatures under stresses. In contrast the cobalt alloys must be more resistant against oxidation: this can be done by applying protective coatings or simply by increasing the Cr content in the alloy, as showed in another poster also presented during Eurocorr 2015 in Graz [4].

[1] Young, D., "High Temperature Oxidation and Corrosion of Metals", Elsevier Corrosion Series, Amsterdam (2008).  
 [2] Conrath, E., Berthod, P., "Kinetic of oxidation of chromium-rich HfC-containing Co-based and Ni-based alloys between 1,000 and 1,100°C", Eurocorr 2014, Pisa.  
 [3] Berthod, P., Conrath, E., "Behaviour of 25wt.%Cr-containing Fe-based alloys strengthened by hafnium carbides in oxidation between 1,000 and 1,200°C", Eurocorr 2014, Pisa.  
 [4] Conrath, E., Berthod, P., "Oxidation behaviours at 1,000, 1,100 and 1,200°C of a 32.5wt.%Cr-containing Co-based alloy reinforced by hafnium carbides", Eurocorr 2015, Graz.