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Oxidation behaviours at 1,000, 1,100 and 1,200°C of a 32.5wt.%Cr -containing Co-based alloy reinforced by hafnium carbides

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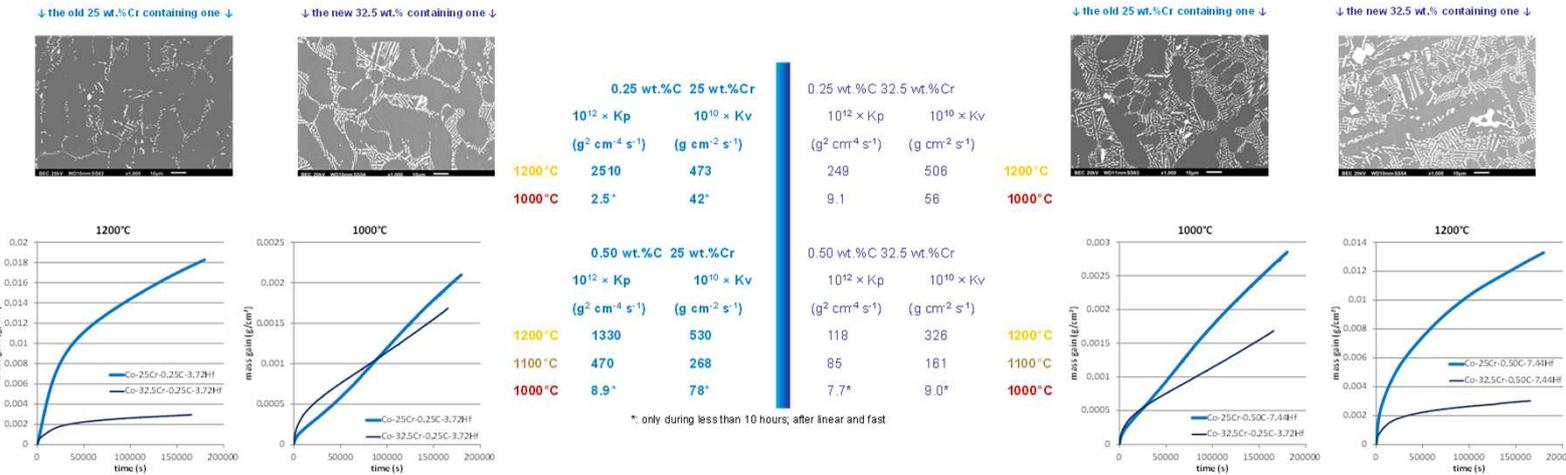
Interdendritic carbides used to strengthen cast superalloys working in hot conditions have to be extremely stable at high temperature. The volume fractions and geometrical shapes of the common chromium carbides evolve too rapidly in such conditions with consequently a lack in mechanical resistance. More stable carbides, as the TaC ones, are themselves not sufficient since they also undergo fraction reduction and fragmentation phenomena. The HfC ones, which present the same script-like morphology as the eutectic TaC, appeared much more resistant to such phenomena [1], and they consequently lead to exceptional creep resistance [2].

However it was recently seen that a significant interdendritic network of eutectic HfC carbides, able to bring high resistance to creep deformation, may also threaten the resistance of the concerned cobalt-based alloys in oxidation at high temperature, by leading to a not chromia-forming behaviour [3-4]. To try improving their oxidation resistance, the chromium content in these alloys was increased from 25wt.% to 32.5wt.%. The new alloys, with always 0.25 to 0.50 wt.%C and 3.7 to 7.4 wt.%Hf but with 7.5wt.%Cr more, were tested in oxidation between 1,000 and 1,200°C for 50 hours in dry synthetic air [5], and the mass gain files characterized according to the $(m \times dm/dt = K_p - K_v \times m)$ method [6]. The oxidized samples are here metallographically characterized to allow interpreting the differences previously observed in the mass gain kinetics.

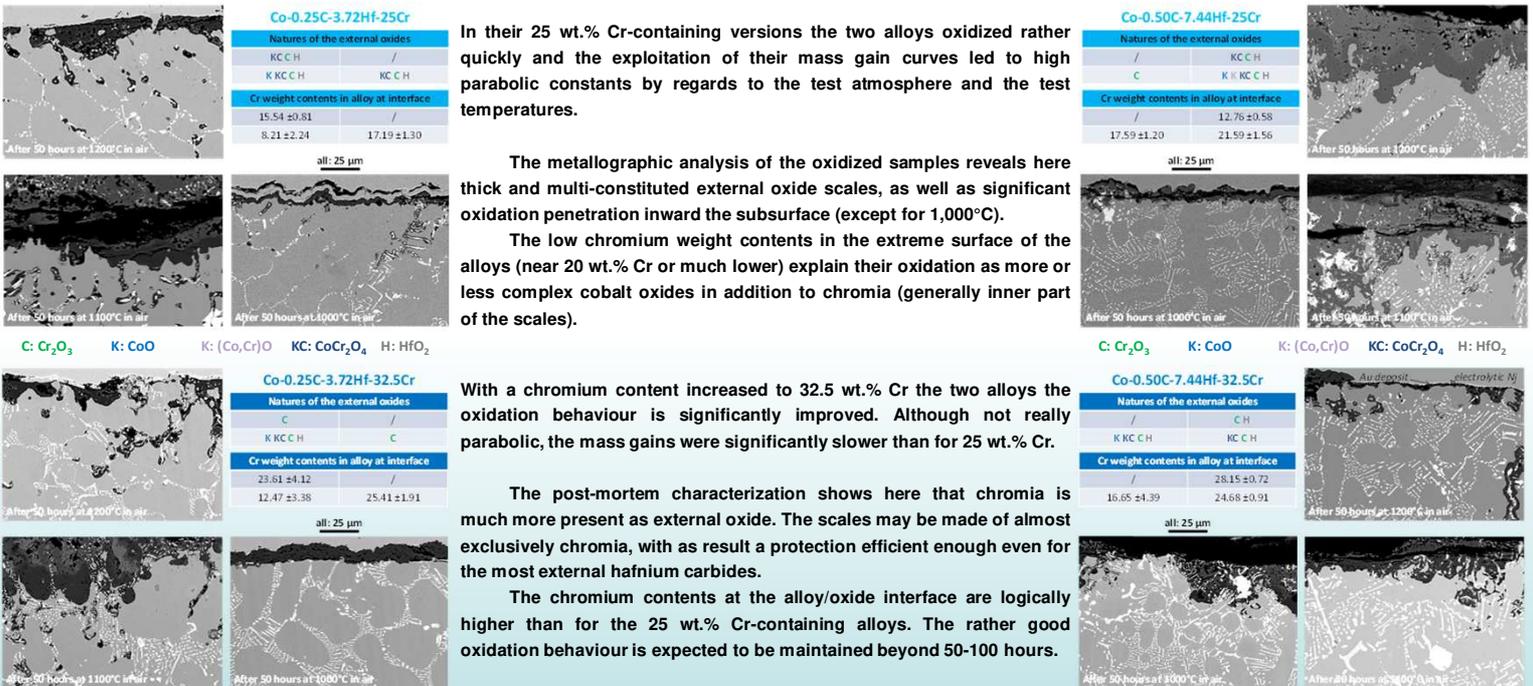
Mass gain kinetics [5]

As-cast microstructures of the (0.25 wt.%C, 3.72 wt.%Hf)-containing alloys; thermogravimetry results

As-cast microstructures of the (0.50 wt.%C, 7.44 wt.%Hf)-containing alloys; thermogravimetry results



Metallography results



[1] Berthod, P., "High temperature properties of several chromium-containing Co-based alloys reinforced by different types of MC carbides (M=Ta, Nb, Hf and/or Zr)", Journal of Alloys and Compounds, Vol. 481 (2009), 746-754.
 [2] Berthod, P., Conrath, E., "Mechanical and Chemical Properties at High Temperature of (M-25Cr)-based Alloys Containing Hafnium Carbides (M=Co, Ni or Fe): Creep Behavior and Oxidation at 1200°C", Journal of Materials Science and Technology Research (open access journal), Vol. 1(1) (2014), pp. 7-14.
 [3] Conrath, E., Berthod, P., "Kinetic of high temperature oxidation of chromium rich HfC reinforced cobalt based alloys", Corrosion Engineering Science and Technology, Vol. 49(1) (2014), pp. 45-54.
 [4] Berthod, P., Conrath, E., "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.
 [5] Conrath, E., Berthod, P., "Kinetic of oxidation at 1000, 1100 and 1200°C of 32.5wt.%Cr-containing Co-based alloys reinforced by hafnium carbides", Eurocorr 2014, Pisa.
 [6] Berthod, P., "Kinetic of high temperature oxidation and chromia volatilization for a binary Ni-Cr alloy", Oxidation of Metals, 64(3-4) (2005), pp. 235-252.