

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



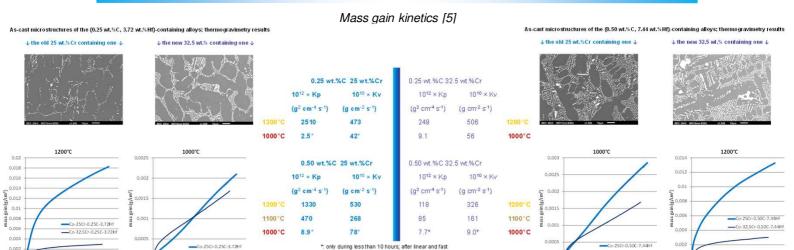
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Interdendritic carbides used to strengthen cast superalloys working in hot conditions have to be extremely stable at high temperature. The volume fractions and geometrical shapes of the common chromium carbides evolve too rapidly in such conditions 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 x dm/dt = Kp - Kv x m} method [6]). The oxidized samples are here metallographically characterized to allow interpreting the differences previously observed in the mass gain kinetics.





In their 25 wt.% Cr-containing versions the two alloys oxidized rather quickly and the exploitation of their mass gain curves led to high parabolic constants by regards to the test atmosphere and the test temperatures.

The metallographic analysis of the oxidized samples reveals here thick and multi-constituted external oxide scales, as well as significant oxidation penetration inward the subsurface (except for 1,000°C).

The low chromium weight contents in the extreme surface of the alloys (near 20 wt.% Cr or much lower) explain their oxidation as more or less complex cobalt oxides in addition to chromia (generally inner part of the scales).

With a chromium content increased to 32.5 wt.% Cr the two allovs the oxidation behaviour is significantly improved. Although not really parabolic, the mass gains were significantly slower than for 25 wt.% Cr.

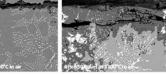
The post-mortem characterization shows here that chromia is much more present as external oxide. The scales may be made of almost exclusively chromia, with as result a protection efficient enough even for the most external hafnium carbides.

The chromium contents at the alloy/oxide interface are logically higher than for the 25 wt.% Cr-containing alloys. The rather good oxidation behaviour is expected to be maintained beyond 50-100 hours.

Co-0.50C-7.44Hf-25C K K KC C 17.59 ±1.20 21.59±1.5 all: 25 µr

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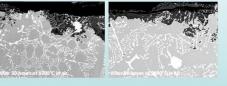




C: Cr,O K: CoO







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earch (open access journal), Vol. 1(1) (2014), pp. 7-14.

C: Cr.O.

K: CoO

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- [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.

Co-32.5Cr-0.25C-3.72H

KC C H

17.19±1.30

25.41+1.91

Co-0.25C-3.72Hf-25C

all: 25 µm

K: (Co,Cr)O KC: CoCr₂O₄ H: HfO

KKCC

23.61 ±4.12

12 47 +3 35

Co-0.25C-3.72Hf-32.5C

all: 25 µn

KKCCH

15 54 +0.81

8.21 ±2.24