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## Behavior of three cast chromium-rich cobalt-based alloys in oxidation at 900°C in a 100% water vapour atmosphere

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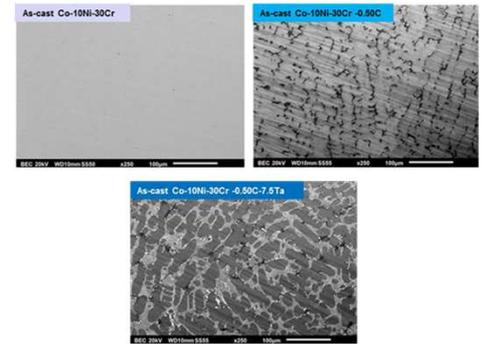
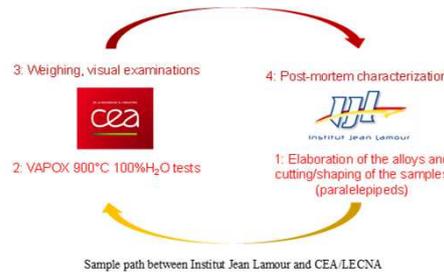
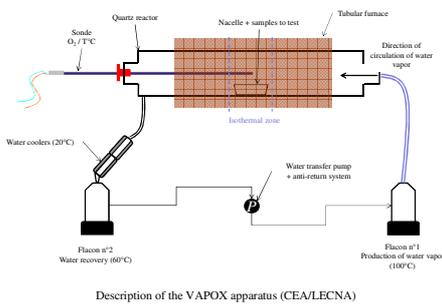
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Beside the famous single-crystalline  $\gamma/\gamma'$  superalloys other metallic alloys retain high interest for some high temperature applications. This is for example the case of the foundry-made cobalt-based superalloys family. These alloys may offer to the users high mechanical strength in service at elevated temperature as well as correct resistance against oxidation by gases and corrosion by molten salts. A typical example of use is as the constitutive material of glass working tool for shaping molten glass. The oxidative gaseous milieu in which cast cobalt-based superalloys work the most often are dry or wet air, or mixtures of burner gases. However there are applications, notably in the nuclear power field, in which hot gases may contain very high quantities of water vapour and for which cobalt-based superalloys may be considered. Their behaviour in such water-rich gaseous environment seems to be never investigated and this is the reason why testing a little series of cast cobalt-based alloys in pure water vapour was decided here.

Work carried out in the frame of the research activities of the GDR N°3583 "EVACOHT"

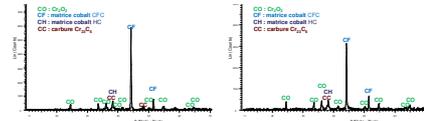
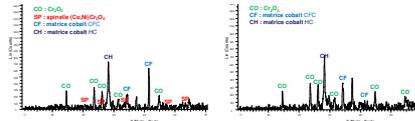
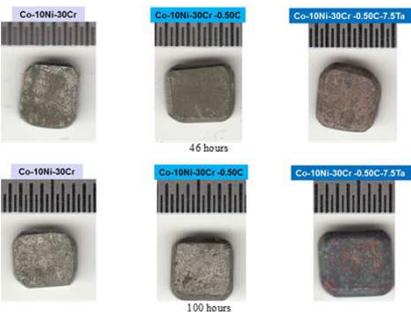
(Groupe De Recherche "Effet de la Vapeur d'eau en Atmosphères complexes sur la Corrosion et l'Oxydation à Haute Température" of the CNRS (Centre National de la Recherche Scientifique))

## Experimental



Three cobalt-based alloys cast by high frequency induction melting  
Co(bal.)-10Ni-30Cr (-0.5C (-7.5Ta))  
Exposed for 46 or 100 hours to pure water vapour heated at 900°C  
SEM/SE&BSE surface and cross-sectional examinations, XRD runs

## Results



More or less oxide spallation at cooling

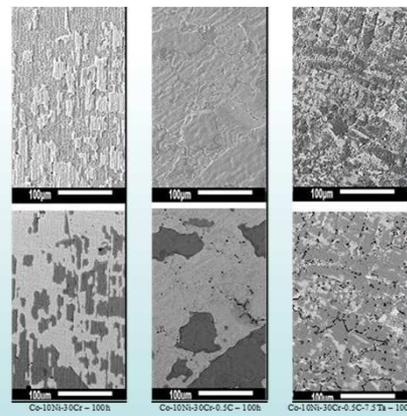
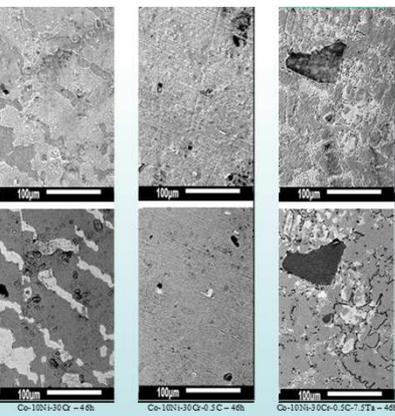
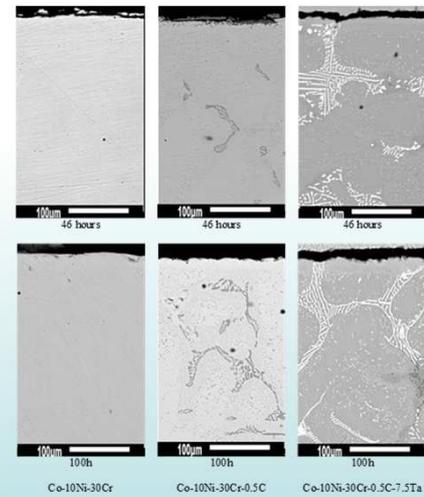
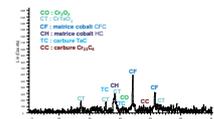
Presence of chromia in all cases

But also presence of (Co,Ni)Cr<sub>2</sub>O<sub>4</sub> spinel oxide in some cases

Systematic presence of CrTaO<sub>4</sub> for the third alloy

Very limited changes in subsurface, in contrast with what usually occurs at T > 1000°C for such alloys in air (900°C is a low temperature for such alloys)

Precipitation of secondary chromium carbides or tantalum carbides in the bulk (900°C is classically chosen for the hardening treatments applied to such alloys)



## Conclusion

The three cobalt-based alloys appeared thus as rather resistant on long time against the atmosphere made of exclusively water vapour for this temperature of 900°C. Oxygen is particularly oxidant (it was present here too, in very small quantity) but water vapour is also known to be an oxidant gas. Water vapour is furthermore favourable to the volatilization of oxide species (unfortunately including the protective chromia and also alumina). This last aspect was not really studied here but may be later specified by using thermogravimetry techniques and by applying numerical treating methods. Sometimes cited for its beneficial effect on the resistance against spallation in thermal cycling, water vapour did not demonstrate this in the present study. It can be thought that such effect exists for some alloys different from the three present ones, or that too much water vapour may have the opposite effect. These are many questions which merit to be further investigated.