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## Protection of simple cast cobalt-based alloys by pack-cementation Cr-deposit and study of their behaviour in high temperature oxidation

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## Introduction

### Actually

Cobalt alloys:

- Less resistance against oxidation than Ni-alloys
- Necessity to contain high quantity in chromium (~30 wt.%)
- 30wt.% Cr are unfortunately in other fields:
  - lowers refractoriness
  - negative effect on creep resistance

### Decrease of the chromium content

- ➔ Increase of the solidus temperature and improvement of the mechanical properties
- ➔ But threatens the resistance against HT oxidation

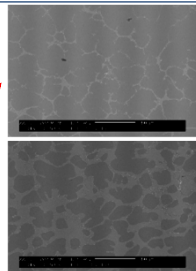
### Improvement of the resistance against oxidation

By Cr-enrichment on the sub-surface of the alloy, e.g. by pack-cementation process

## Compositions and microstructures

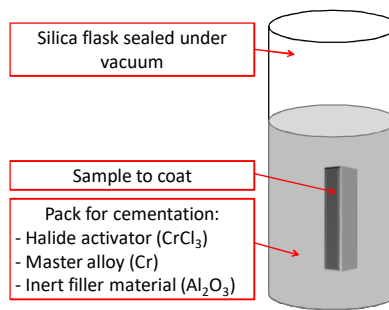
	Co	Cr	Ta	C
CoTa1	87.3 (±0.7)	10.3 (±0.1)	4.5 (±0.4)	0.25 /
CoTa2	83.6 (± 1.5)	10.5 (±0.1)	8.5 (±1.5)	0.50 /

Co-based alloys reinforced by TaC carbides

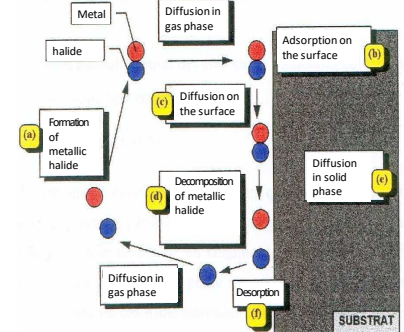


## Pack-cementation

### Technique

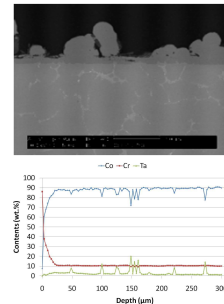


### Principe

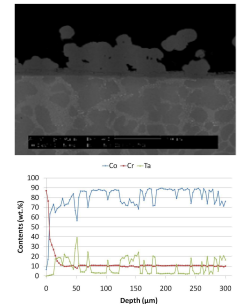


## Cementation: 7h30 at 1050°C

### CoTa1



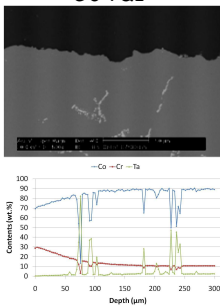
### CoTa2



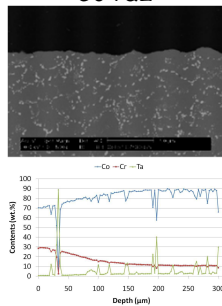
Enrichment of the sub-surface in chromium over depths of about 20-30 µm

## Cementation: 7h30 (or 15h) at 1050°C and diffusion treatment: 75h at 1200°C

### CoTa1



### CoTa2



7h30-Coated alloys	CoTa1	CoTa2
Cr-content on the surface (wt.%)	28.9 (± 0.1)	29.1 (± 0.5)
Enriched depth (µm)	194	205

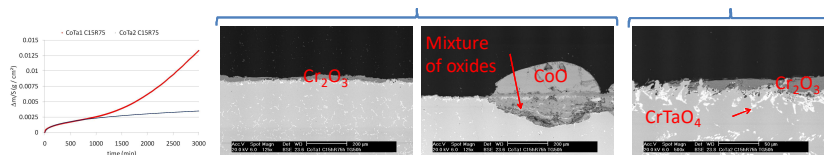
15h-Coated alloys	CoTa1	CoTa2
Cr-content on the surface (wt.%)	29.0 (± 0.5)	29.5 (± 0.6)
Enriched depth (µm)	220	257

diffusion treatment:

Cr-enrichment of the sub-surface (~30 wt.%) over 200 µm or more

## Resistance to oxidation at 1200°C for 50h (TGA)

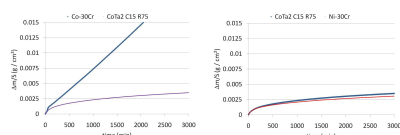
### Results



Alloy CoTa1: Correct thermogravimetry curves during approximately ten hours then he fast increase because of an important local oxidation

Alloy CoTa2: Correct curves during 50h to oxidation, confirmed by the surface states

### CoTa2 C15R75 : Comparison with two simple 30 wt.% Cr alloys



Coated CoTa2:

- Much better than Co-30Cr
- Equivalent to Ni-30Cr (Good behaviour in high temperature oxidation)

## Conclusions

Cementation:

- Good Cr-enrichment of the sub-surface (~30 wt.%)
- Enrichment-depth depends on alloy et on time-cementation

Oxidation:

- In furnace, correct resistance for all coated alloys
- Thermogravimetry results:
  - Variable results
  - Good result for CoTa2, equivalent to the Ni-30Cr alloy