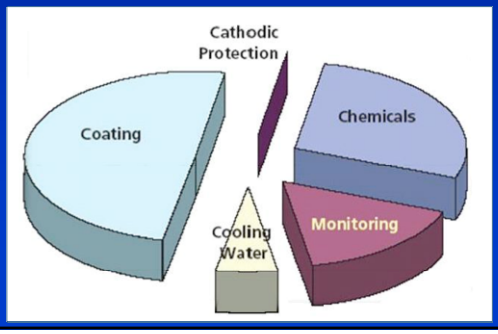
High Temperature Oxidation of MCrAlY's

Cory Kaplin

- Maintenance is a major expense in all industries, and corrosion is easily the most significant maintenance issue for most.
- In 1998, it was estimated that the direct cost of corrosion in the United States was 6% of the GNP.
- 60% to 70% of the plant maintenance budget, 15% and 25% of the plant operating budget in refineries.
- Constant monitoring of the equipment, preventive replacement, the choice of proper corrosion resistant alloys and coatings.

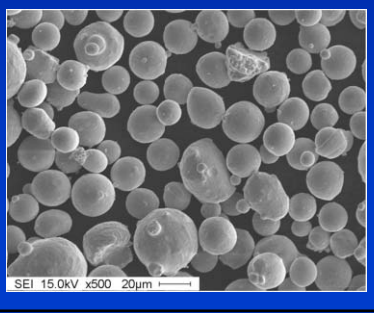


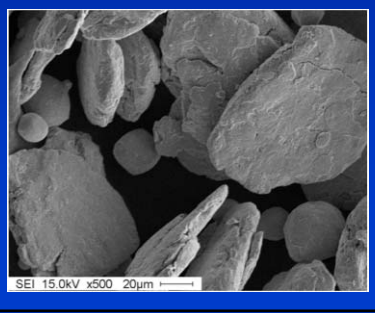
Introduction

The Coating:

CoNiCrAlY & NiCoCrAlY HVOF coatings

Aerospace coating for high temp applications
Known for good corrosion and oxidation resistance through formation of an oxide scale.
Cryomilling for 8 hours to form nanostructure.





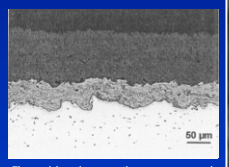
Scope

So what will we model?

High termperature Oxidation/Corrosion reaction at surface, coating forms an oxide scale.

Model interface reaction of alloys:

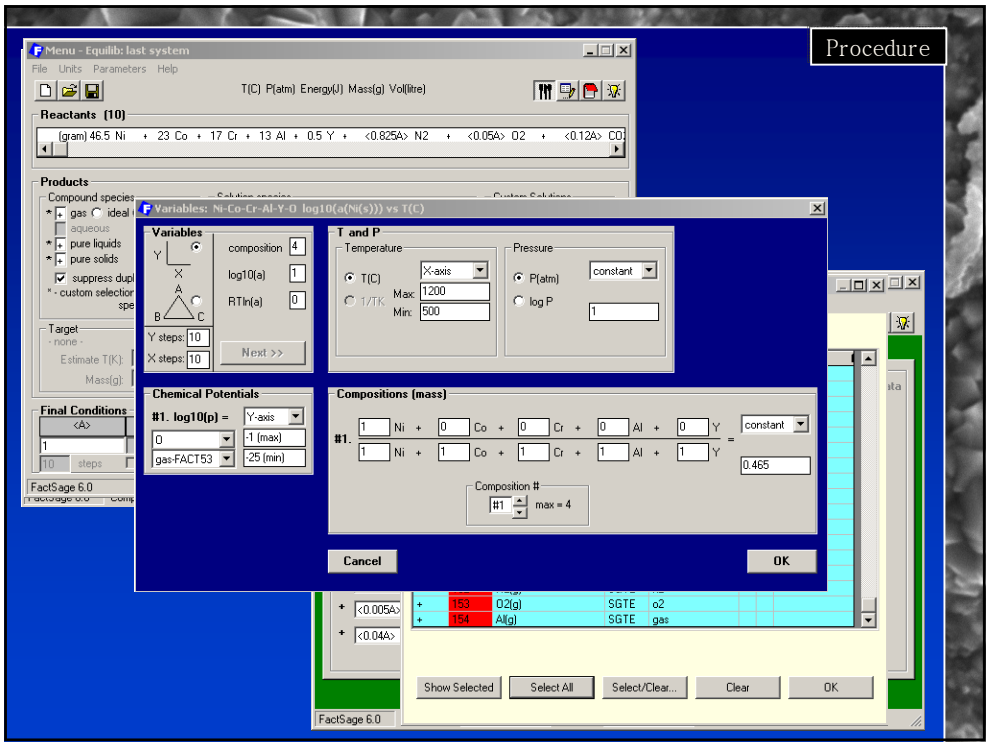
Alloy Composition (%)					
	Co	Ni	Cr	Al	Y
CoNiCrAlY:	38.5	32	21	8	0.5
NiCoCrAlY:	23	46.5	17	13	0.5

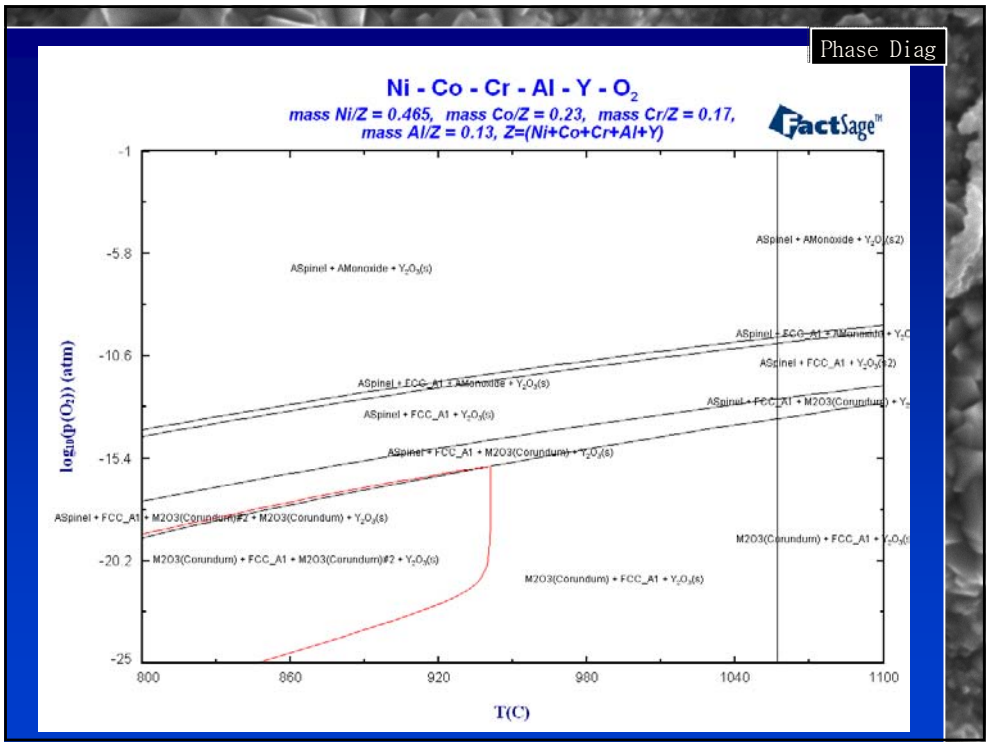


Therml barrier coating composed of a CoNiCrAlY bond coat on a nickel based superalloy

Exposed to air or SO_2 mixture at 800 and 1000° C

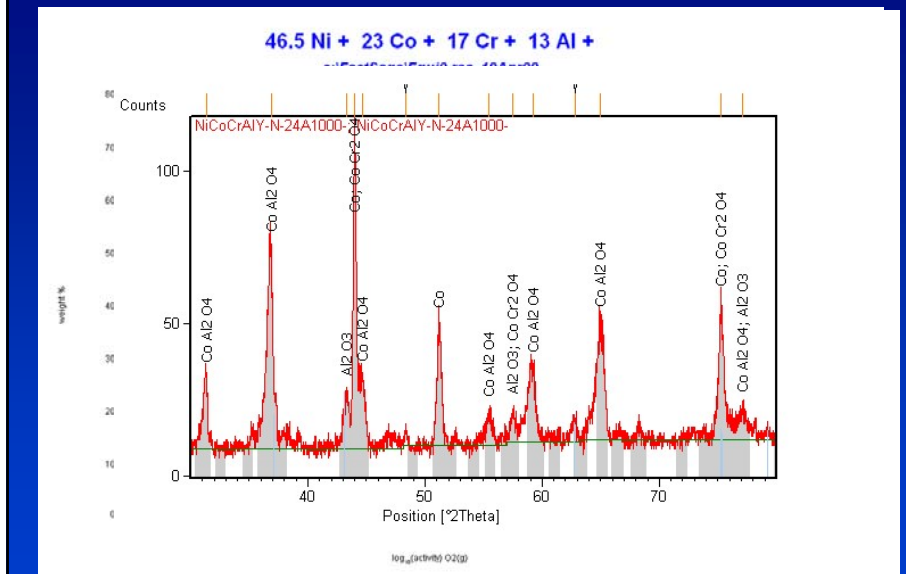
SO_2 Mixture (%)			
SO_2	O_2	CO_2	N_2
0.5	5	12.5	82.5


Procedure
Menu - Equilib: last system
File Units Parameters Help
T(C) P(atm) Energy(J) Mass(g) Vol(litre)
Reactants (10)
Products
Variables: Ni-Co-Cr-Al-Y-O log10(a(Ni(s))) vs T(C)
Variables
composition 4
log10(a) 1
RTln(a) 0
Y steps: 10
X steps: 10
Next >>
T and P
Temperature
T(C)
1/TK
X-axis
Max: 1200
Min: 500
Pressure
P(atm)
constant
log P
1
Chemical Potentials
#1. log10(p) =
Y-axis
-1 (max)
-25 (min)
gas-FACT53
Compositions (mass)
#1.
Ni Co Cr Al Y
constant
0.465
Composition #
#1
max = 4
Cancel
OK
153 O2(g) SGTE o2
154 Al(g) SGTE gas
Show Selected
Select All
Select/Clear...
Clear
OK
FactSage 6.0


Phase Diag
Ni - Co - Cr - Al - Y - O2
mass Ni/Z = 0.465, mass Co/Z = 0.23, mass Cr/Z = 0.17,
mass Al/Z = 0.13, Z=(Ni+Co+Cr+Al+Y)
FactSage
log10(p(O2)) (atm)
T(C)
-1
-5.8
-10.6
-15.4
-20.2
-25
800
860
920
980
1040
1100
ASpinel + AMonoxide + Y2O3(s)
ASpinel + FCC_A1 + Y2O3(s)
ASpinel + FCC_A1 + M2O3(Corundum) + Y2O3(s)
M2O3(Corundum) + FCC_A1 + Y2O3(s)

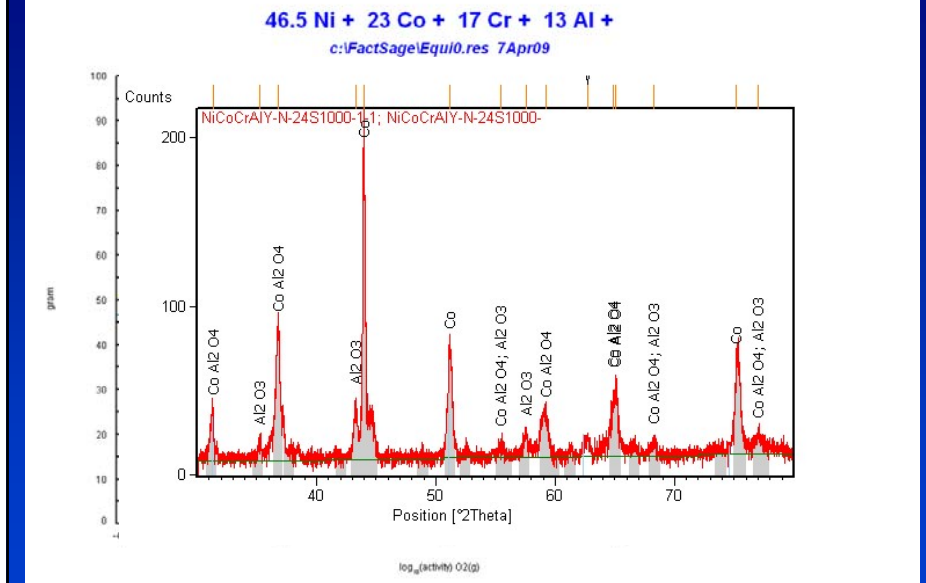
Air

NiCoCrAlY in Air, Solution Summary

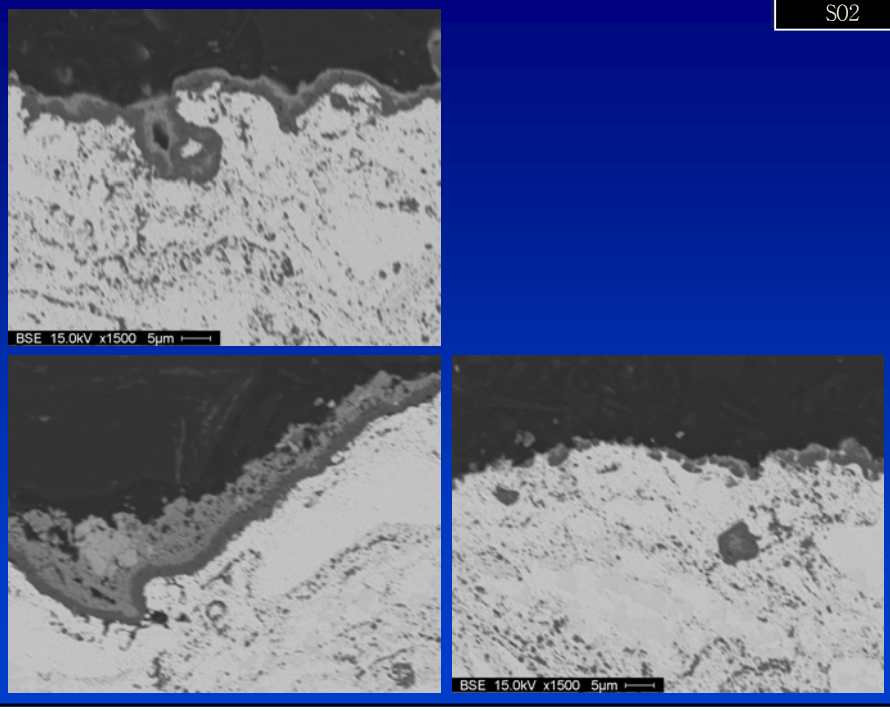


S02

NiCoCrAlY in SO2, Solution Summary

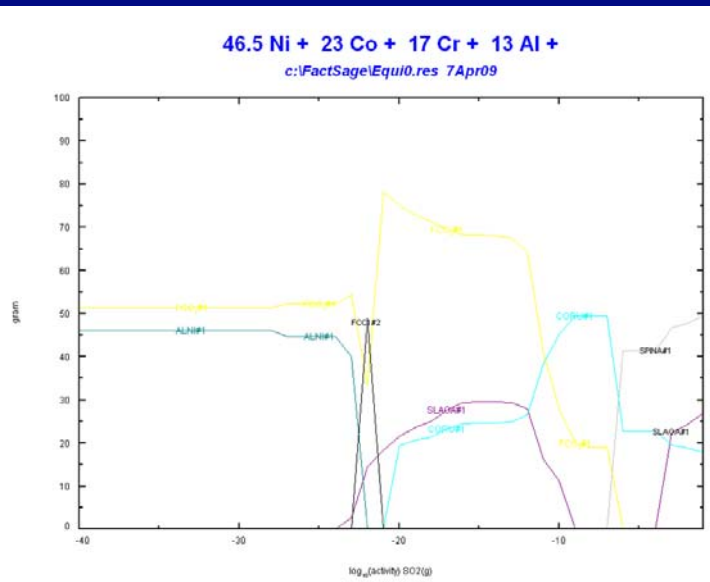


S02



S02

NiCoCrAlY in Air, Solution Summary in SO2 activity



Conclusions

Conclusions:

MCrAlY's generally form a base layer of alumina in a corundum structure followed by a spinel layer of mixed oxides.

Reactions in an SO2 environment are generally governed by the oxidation reaction.

The parallel corrosion reaction does not have an effect on oxidation layers, however FactSage does not account material loss.

Thank you...

Questions?