

New Investigation Results of Crofer 22 APU

Hojda/Singheiser/Quadackers



Development Challenges for Fuel Cell Materials

- Excellent High-Temperature Oxidation Resistance
- Good Electrical Conductivity of the Oxide Scale
- Thermal Expansion Similar to Ceramics (e.g. YSZ)
- No Detrimental Reaction (Cr-Oxide Evaporation)
- Adequate Strength at High Temperature
- Easy Manufacturing
- High Potential for Cost Reduction



Material Specification

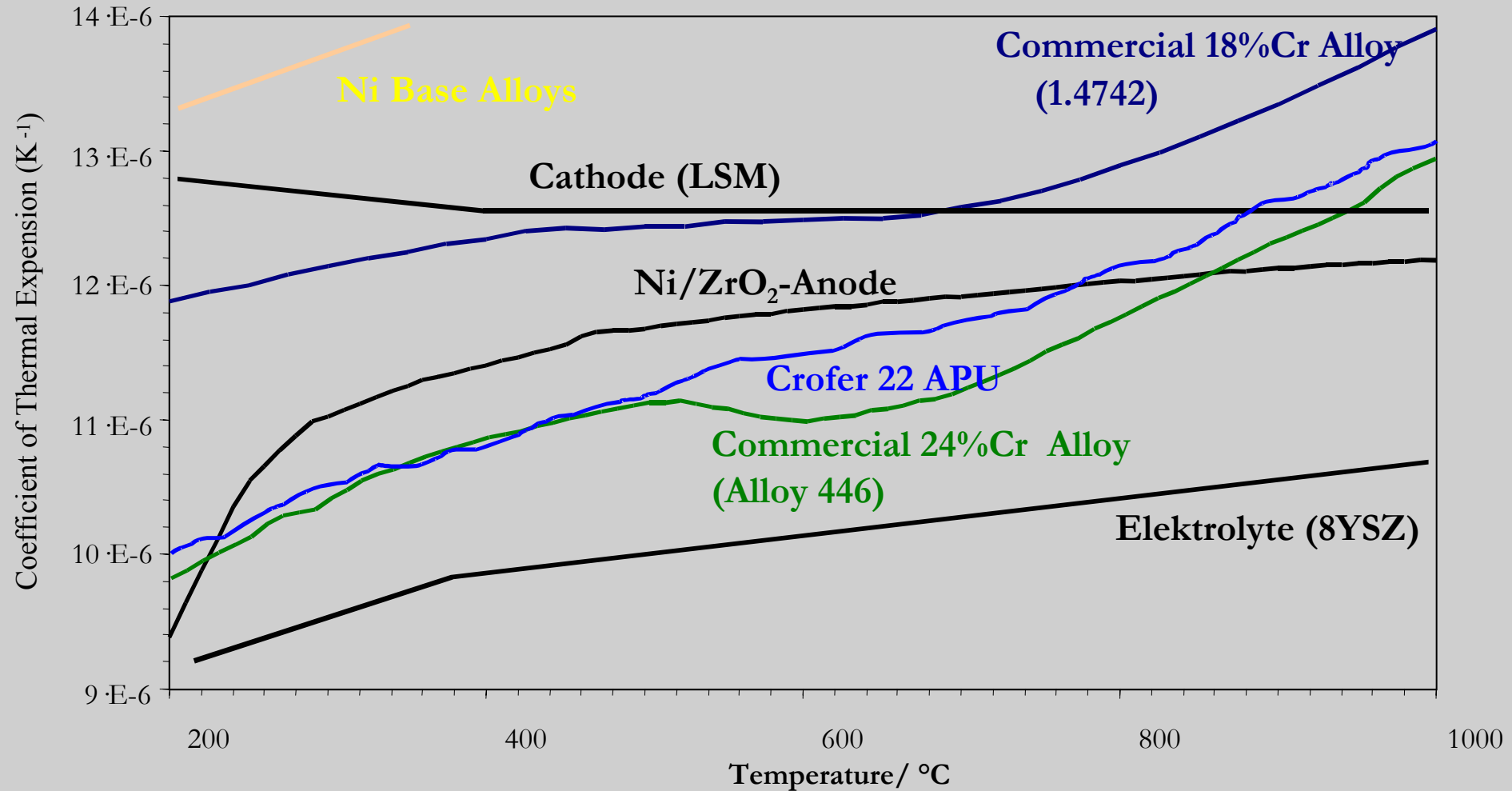
Analysis:	Fe / Cr 22 / Mn 0.8 / Ti 0.2 / La 0.2
Density:	7,67 g/cm ³
Resistivity:	0,54 Ohm* mm ² /m
Yield Strength:	300 – 400 MPa
Tensile Strength:	450 – 550 MPa
Elongation:	30 – 40 %



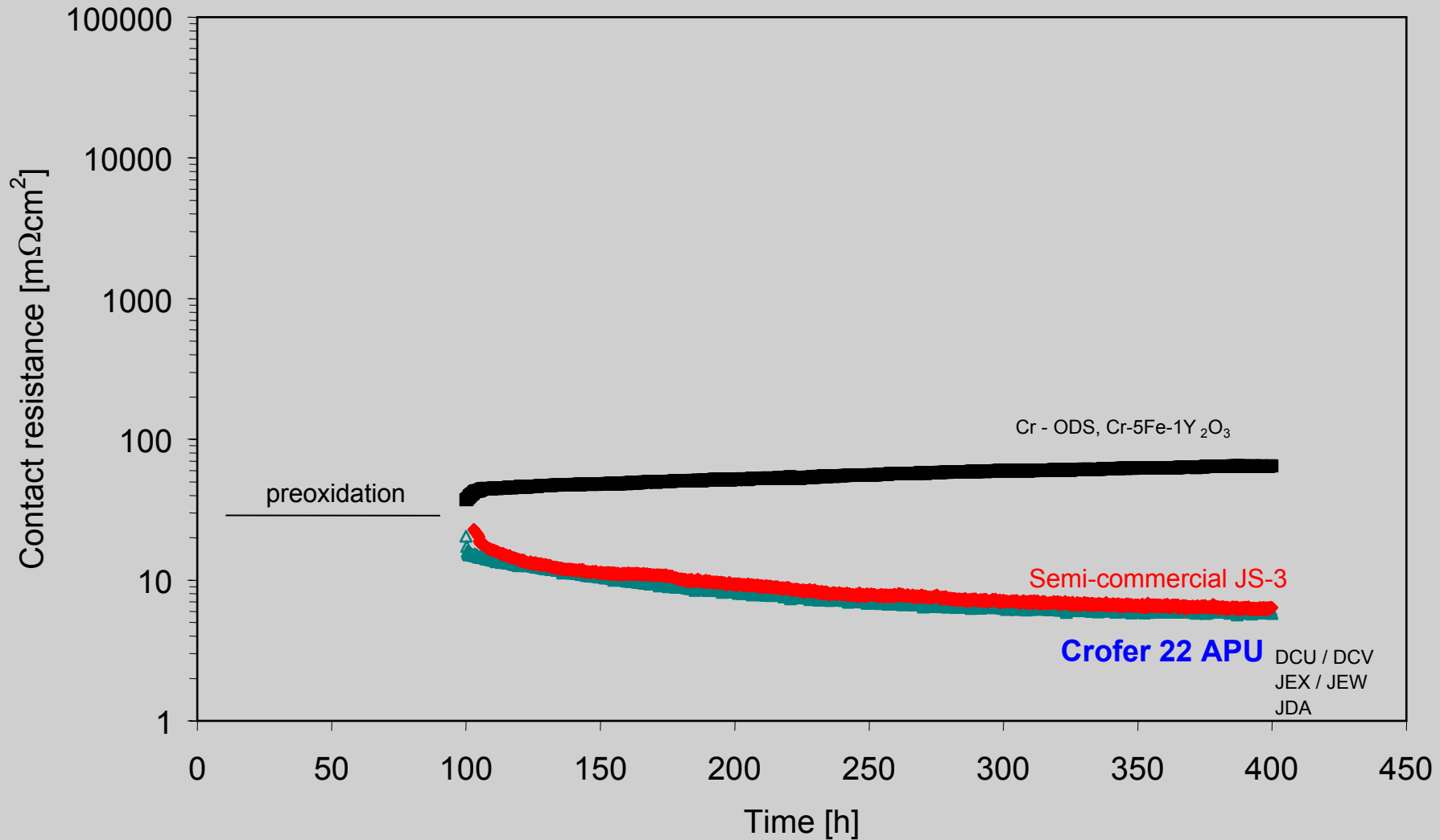
Properties/Workability similar to Ferritic Stainless Steels



Coefficient of Thermal Expansion

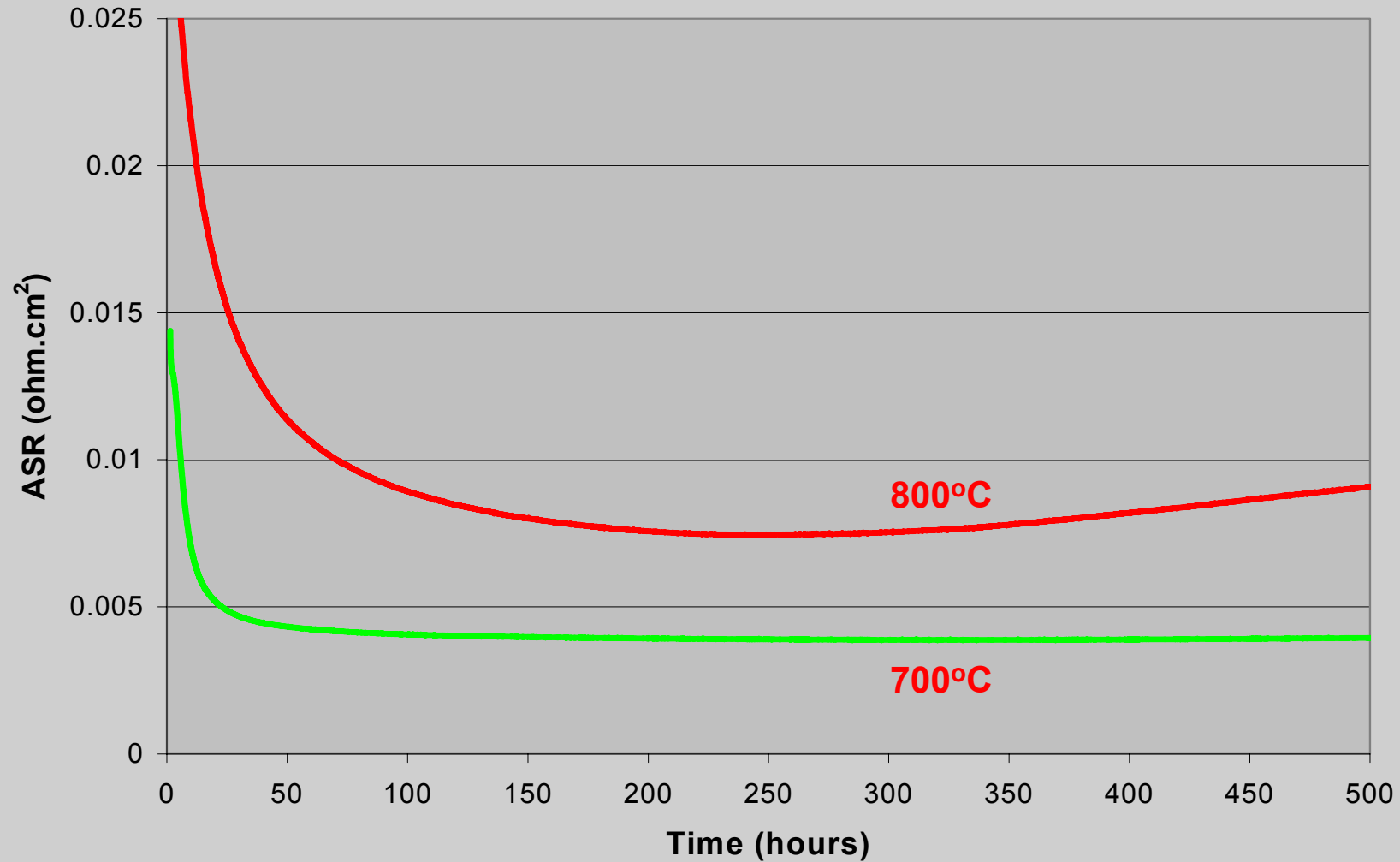


Contact Resistance at 800°C in Air



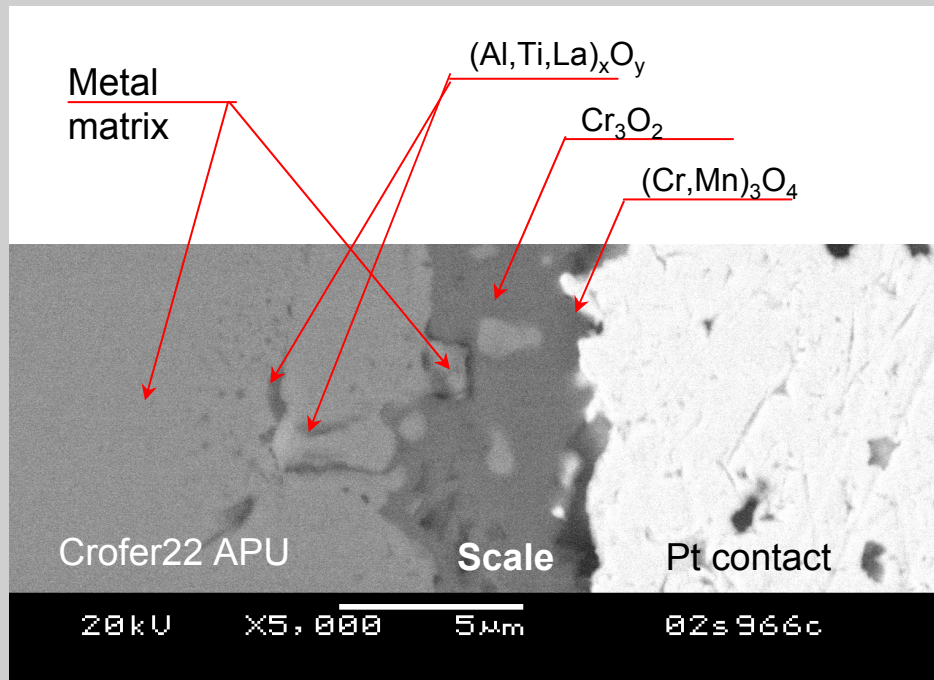
Scale Resistance Crofer 22 APU

Pacific Northwest National Laboratory
U.S. Department of Energy

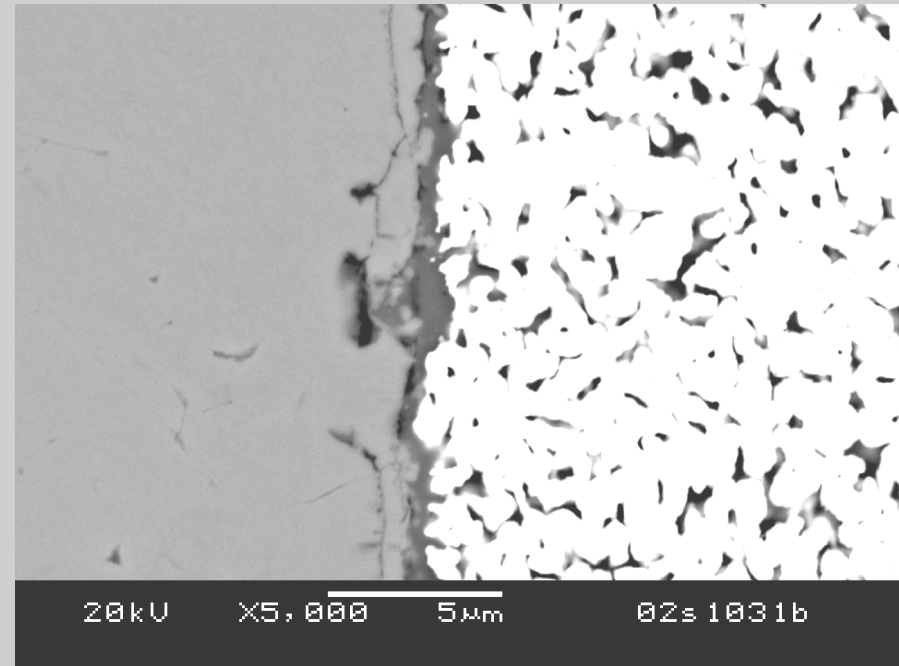


Microstructures of Crofer 22 APU

800°C, 500h

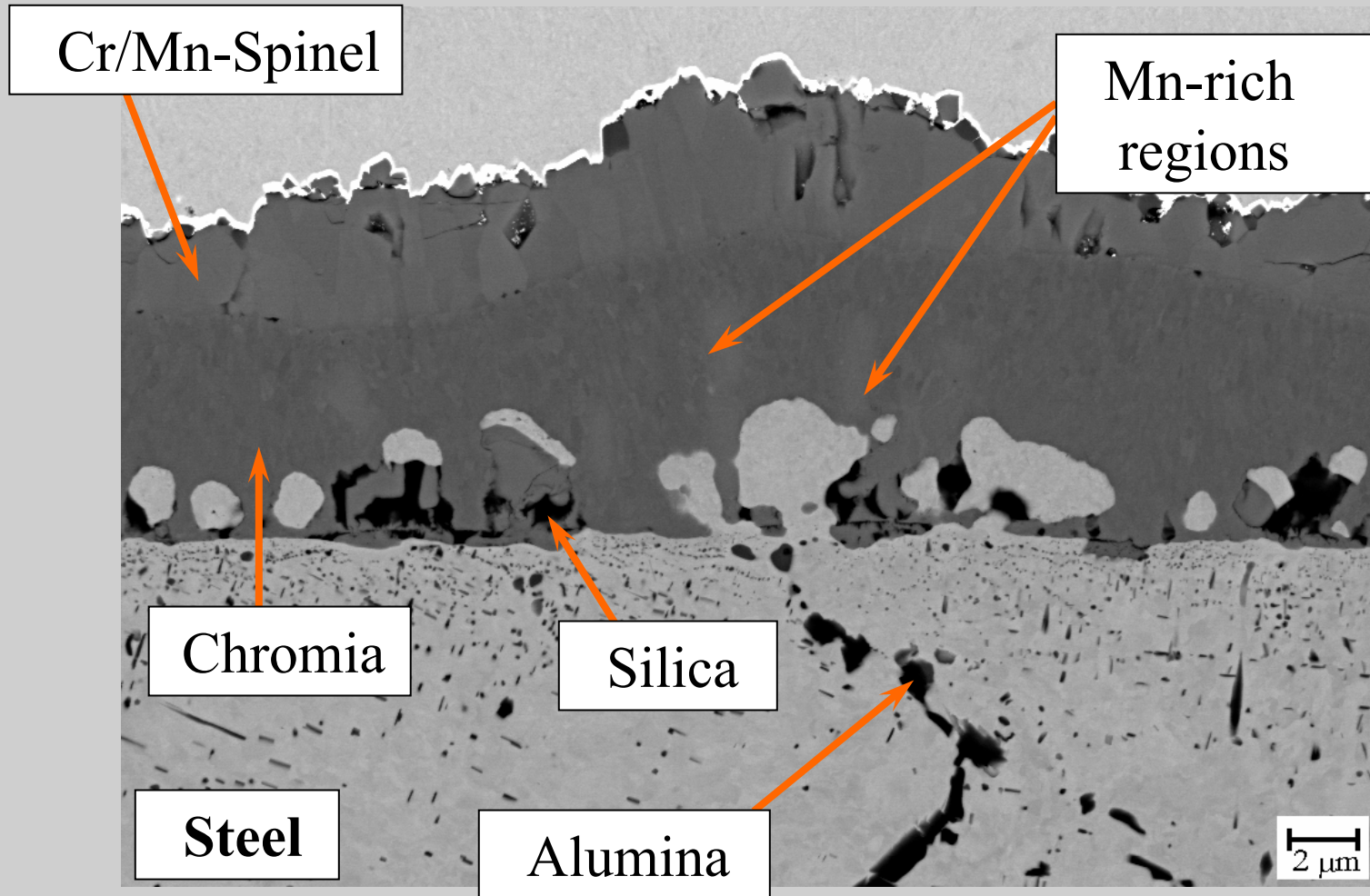


700°C, 500h

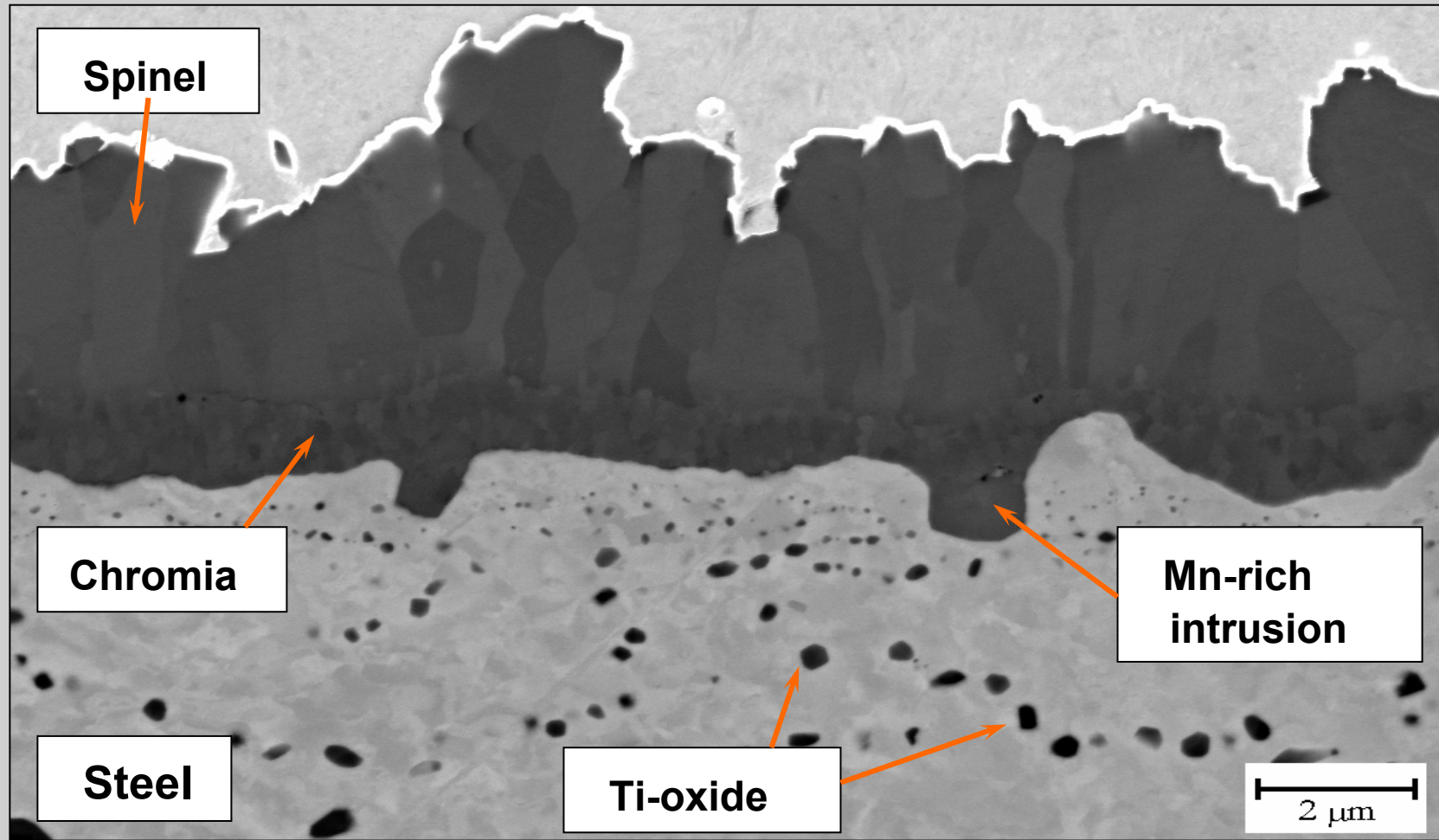


Note: Reduced Cr volatility due to $(Cr, Mn)_3 O_4$ outer scale

SEM Cross-Section Crofer 22 APU 6000h/800°C/Air

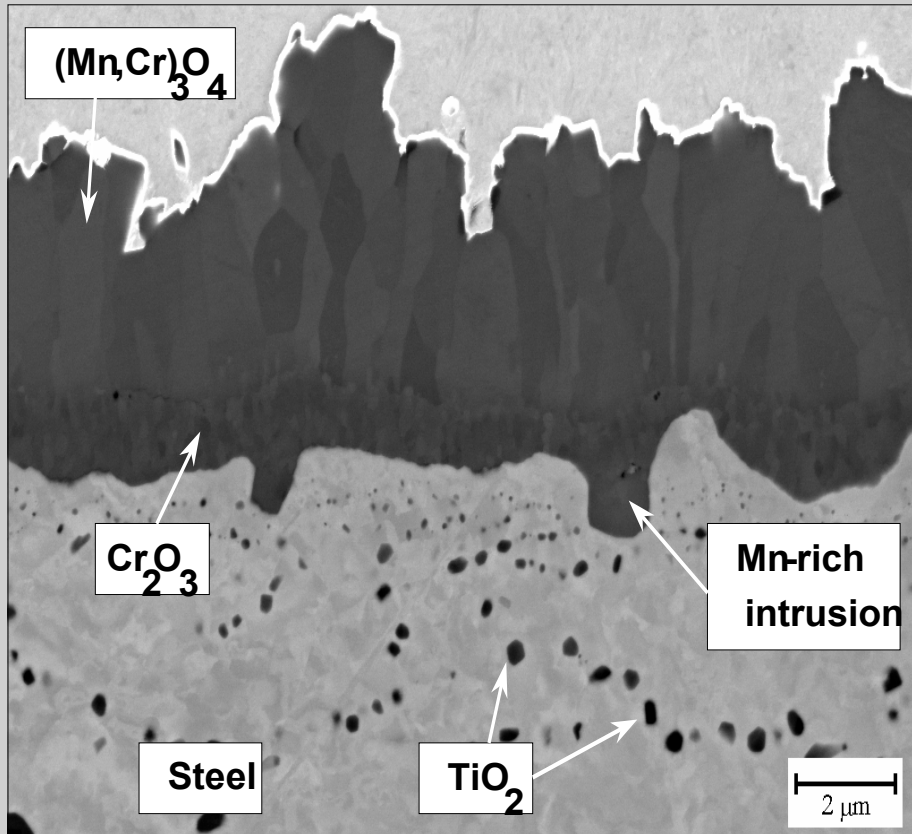


SEM Cross-Section of JS 3 (6000h/800°C/Air)

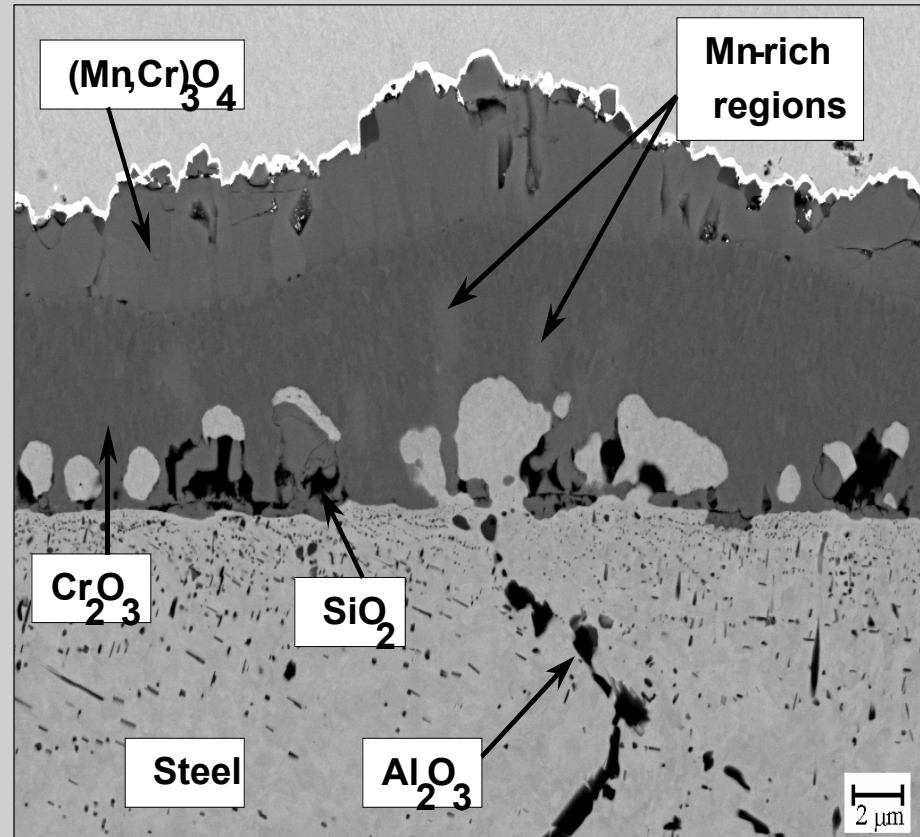


Comparison of Scale Formation JS 3 to Crofer 22 APU

(6000h/800°C/Air)



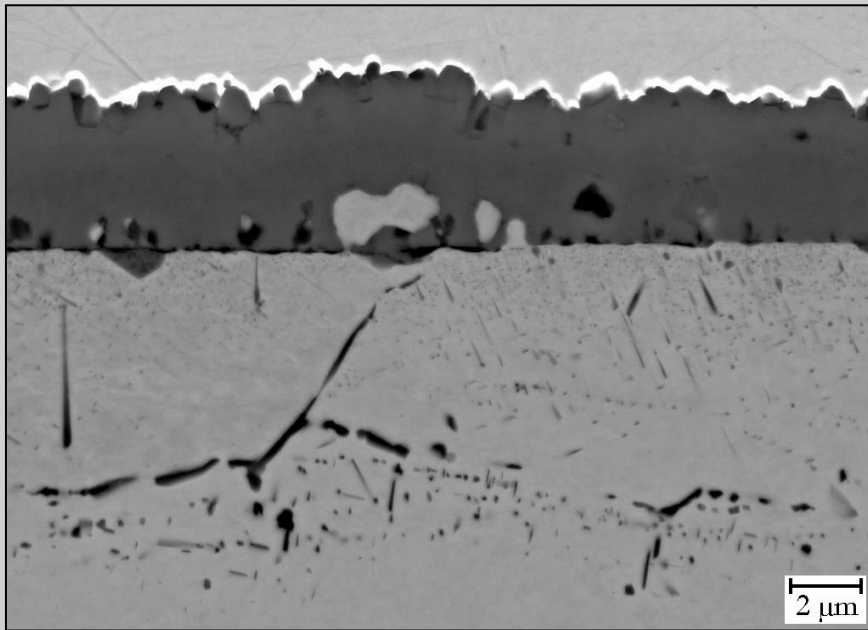
JS-3



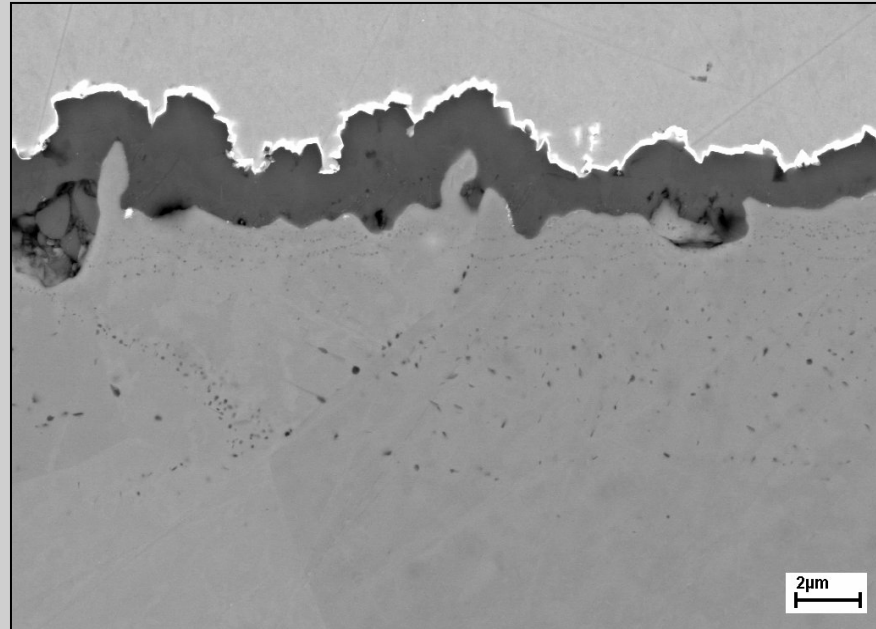
Crofer 22 APU_{Batch JDA}

Adjustment of Scale Formation on Crofer 22 APU

1000h/800°C/Air (cyclic oxidation)

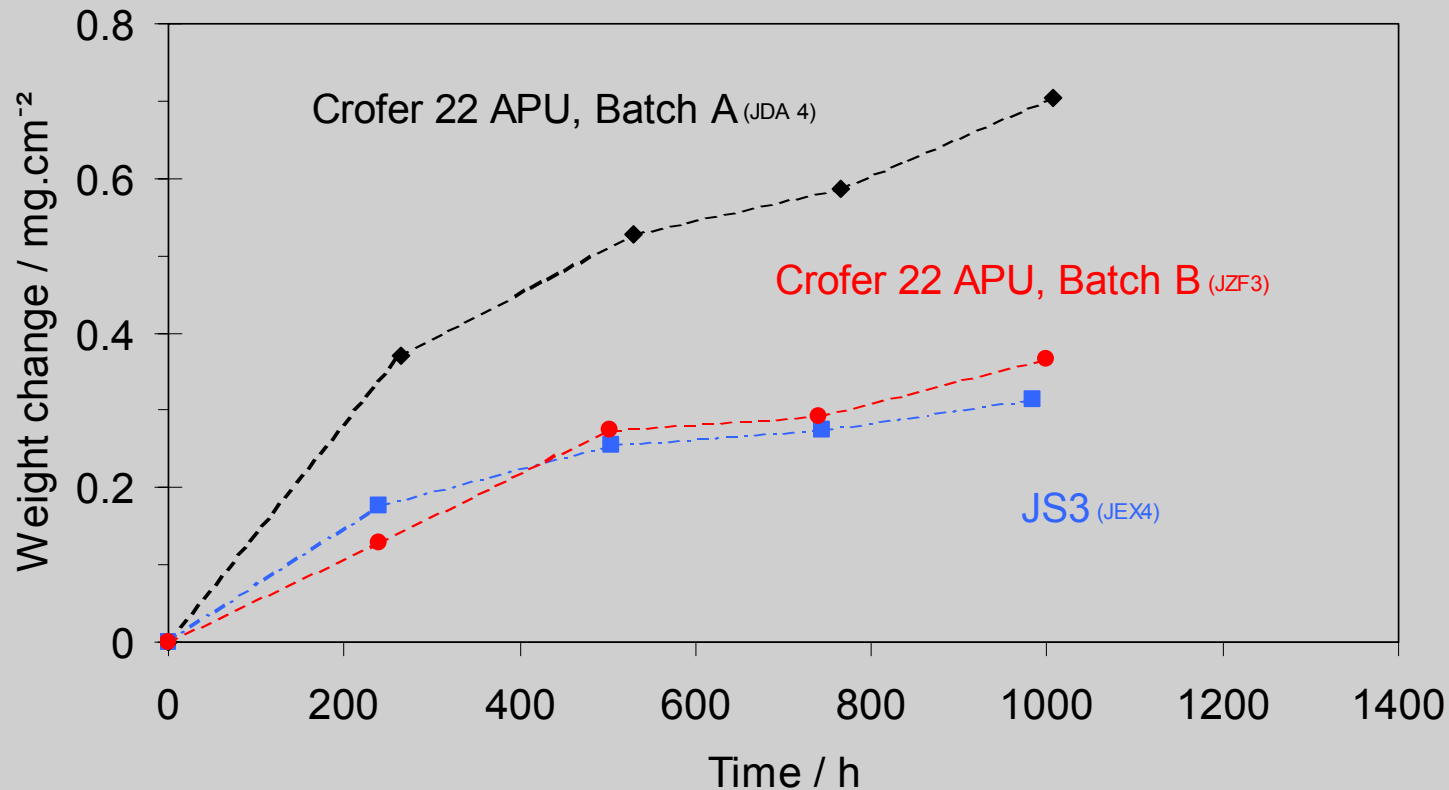


Batch A (JDA)



Batch B (JZF)

Discontinuous Oxidation of Crofer 22 APU



Specially designed Crofer 22 APU

- 22% Cr for Oxidation Resistance and low CTE
- 0.6% Mn addition for
 - Limitation of Cr evaporation
 - Good Conductivity of the Oxide Scale
- 0.1% La to improve Oxide Scale Adherence

Continuous Process Improvement → Crofer 22 APU = JS-3 !

