DECHEMA FORSCHUNGSINSTITUT

Aluminide coatings on thin walled sheets for industrial furnaces

J.T. Bauer, H. Ackermann, M.C. Galetz| bauer@dechema.de |1st December 2014 – 31th December 2017|

Motivation

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Demands

Mechanical
- Thermocycles
- Low stresses (2-6MPa)

Corrosive
- Burner atmosphere
- Exhaust gas atmosphere
- N_2, CO_2, H_2O, O_2

High temperature

State of the art
- Ni-base-alloys
- **Thick** substrate +thin coating

→

This project
- Austenitic steels +diffusion coating
- **Thin** substrate +coating

Challenge

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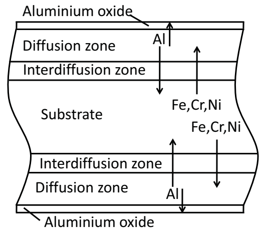

Diffusion causes changes in phase composition and microstructure
→Critical for thin walled samples?

Samples and materials

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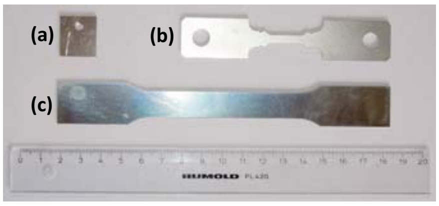
- 1.4828/ X15CrNiSi20-12
- 1.4841/ X15CrNiSi25-21



Manufactured samples for the thermocyclic testing (a), creep testing (b) and tensile testing (c).

Experimental

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Mechanical
- Thermocyclic tests (T_{max}=1000°C)
- Creep tests (2-6MPa, 1000°C)
- Tensile tests at RT

Corrosive
- N_2, CO_2, H_2O, O_2
- Air
- Isothermal (1000°C)

Characterisation
- Metallographie
- EPMA
- Phase analysis

- 1 and 3mm sheets
- Coating thicknesses: 30-130µm

Results - Mechanical aspects

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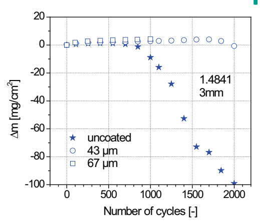
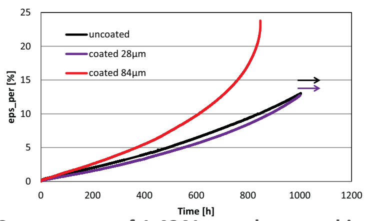
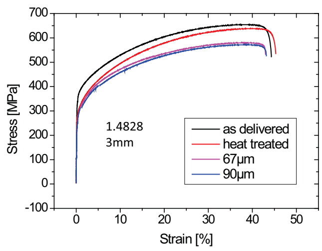
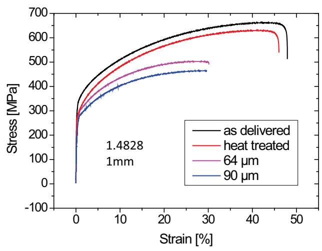


Thermocycling: Uncoated 1.4841 shows break-away after 800 cycles, coated samples show significantly improved behaviour.



Creep curves of 1.4841 samples tested in air at 1000°C. The coating thickness is crucial for creep behaviour.





Tensile tests show a strong influence of the coatings on the mechanical properties for the 1 mm and a small one for the 3 mm samples.

Results - Corrosive aspects

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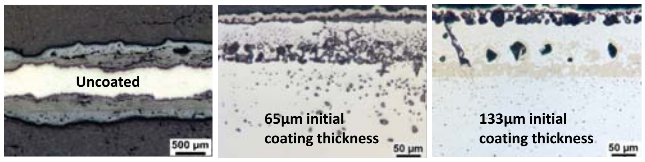
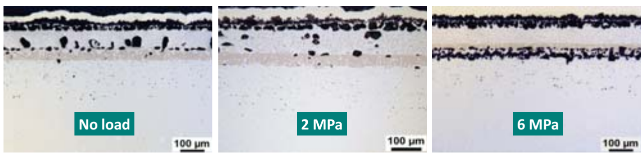


Cross sections of 1 mm samples after 2000 h in synthetic exhaust gas atmosphere, material 1.4828. More than half of the material is lost in the case of the uncoated sample. Thick coatings show better long term protection than thin coatings.



Cross sections of 1 mm samples after 1000 h creep testing in synthetic exhaust gas atmosphere, material 1.4828. All samples had the same initial coating thickness of 107 µm. High stress leads to severe Kirkendall porosity, low stress is not critical.

Conclusions

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- The aluminide coatings have to be optimised for each substrate due to their influence on the mechanical properties
- Aluminide coatings enhance the long term protection of austenitic steels against high temperature corrosion

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