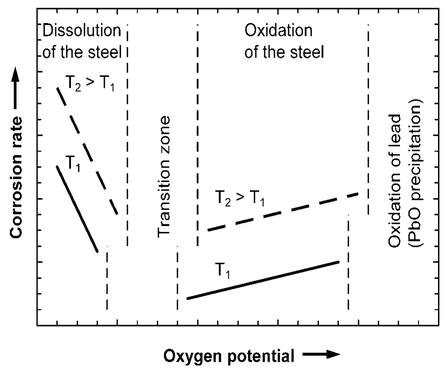
Corrosion resistance of nickel-chromium alloys in oxygen-containing liquid lead at 750°C

Karlsruhe Institute of Technology
Institute for Applied Materials
Material Process Technology
Corrosion Department

O. Picho, C. Schroer and J. Konys

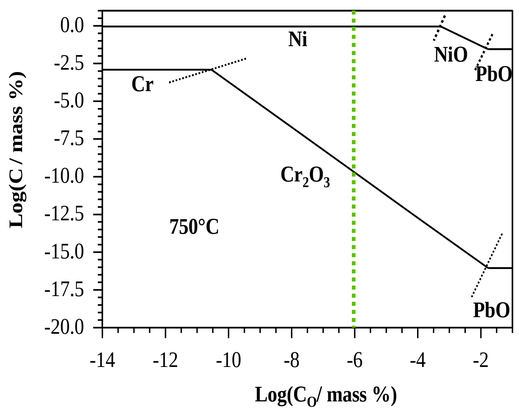
Scope

For future lead-cooled fast reactors (LFR) with improved efficiency, higher operating temperatures of 750°C and more are envisaged. High- Ni steels or Ni-based alloys have to be used because of their superior high-temperature mechanical properties.



Qualitative performance of steels as a function of oxygen potential in liquid lead alloys.

In order to minimize dissolution of metallic structure materials, oxygen is added to liquid lead, so as to promote formation of self-healing protective oxide films on the material surfaces.

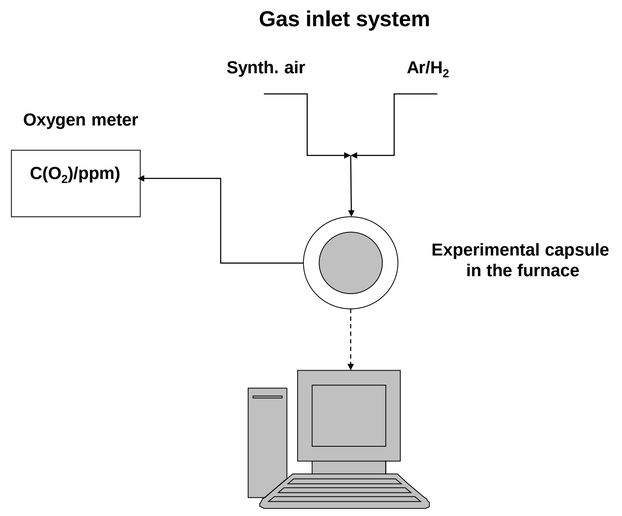


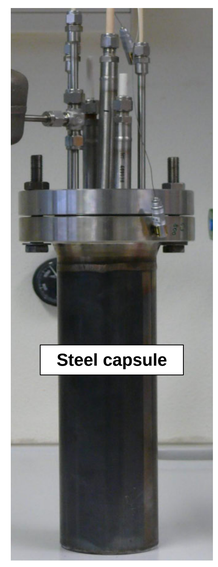
Concentration of Ni and Cr dissolved in Pb at 750°C.

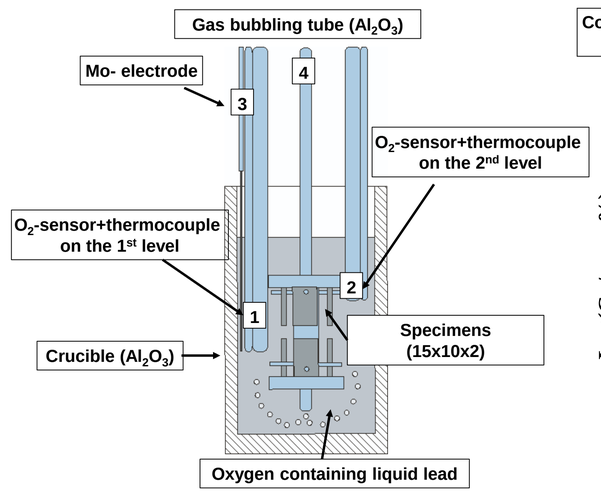
Investigation on binary Ni-Cr-alloys (with 0, 25, 30, 35 and 48 mass % Cr) in stagnant liquid lead at 750°C and c_o=10^{-6} mass % dissolved oxygen :

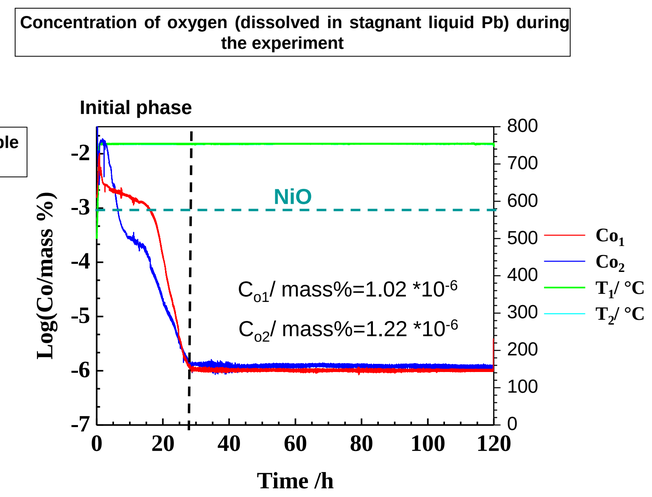
- **Ni dissolution**
- **Cr_2O_3 formation, protection against material dissolution**
- **Impact of Al in the ternary Ni-35Cr-5Al alloy**

Experimental setup





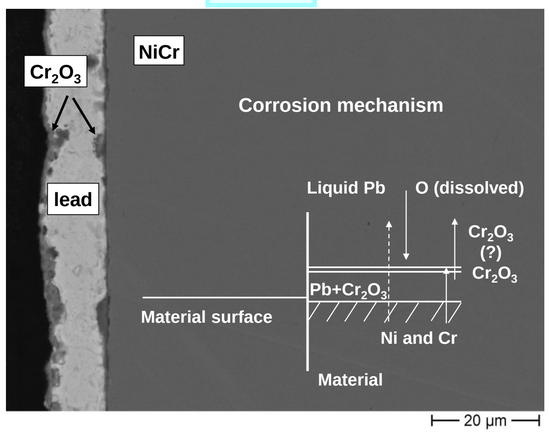




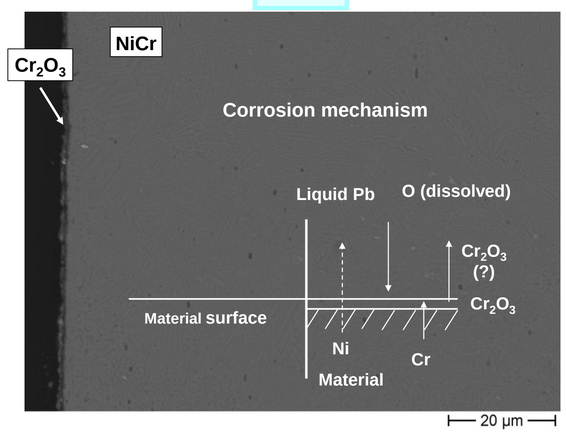
Oxidation and dissolution behavior of nickel-chromium alloys at 750°C

Initial phase/ 0-24h

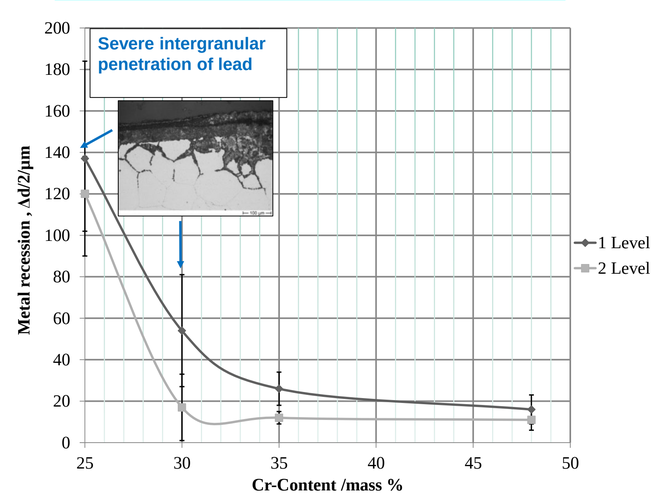
Ni30Cr



Ni48Cr

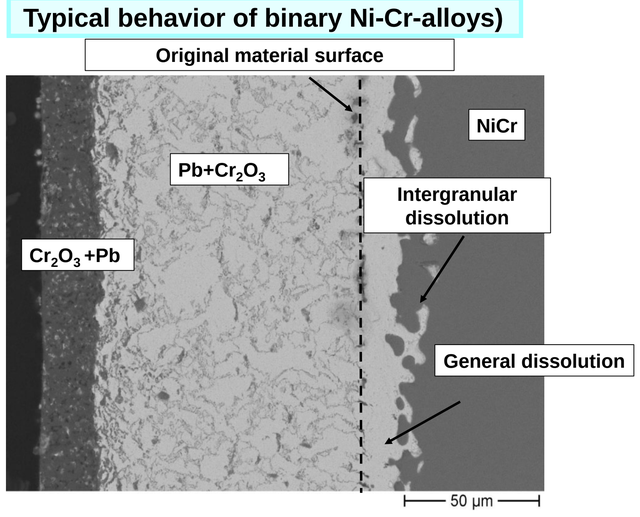


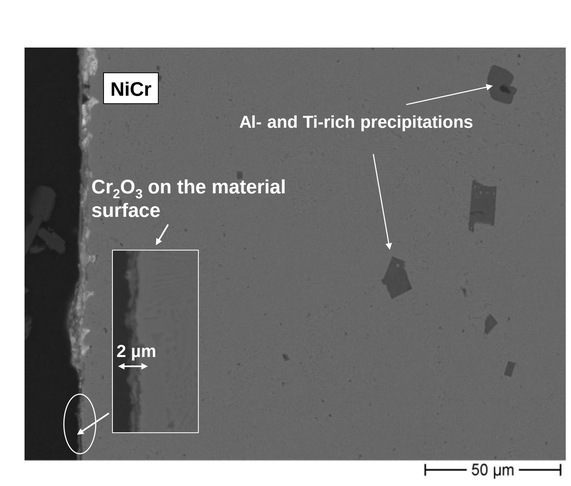
Material loss depending on Cr-content



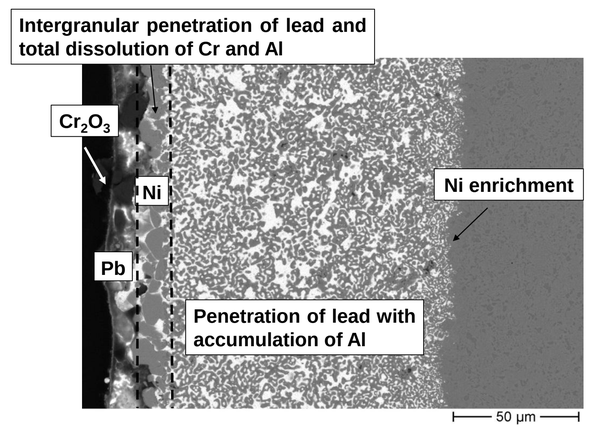
After exposure for 120h

Typical behavior of binary Ni-Cr-alloys)





Influence of 5 mass % Al



Corrosion scale of Ni-Cr alloy with 35 mass % Cr and 5 mass % Al

Conclusions

- **Cr_2O_3 - layer formation on the material surface was observed only for the alloy with 48 mass % Cr, no significant dissolution and lead penetration.**
- **For lower Cr-content, Cr_2O_3 forms away from the material surface. Cr-dissolution and precipitations in the form of oxide in oxygen gradient at the material surface.**
- **Pure Ni completely dissolved during of exposure for 120 h.**
- **5 mass % Al in Ni35Cr-alloy does not improve the corrosion resistance, rather promotes the material dissolution.**

Acknowledgements

- **GETMAT (contract no. FP7-212175) for funding a PhD-project**
- **Olaf Wedemeyer, Josef Novotny and Alexandr Skrypnik for supporting the experimental work**