



SAMOFAR Final meeting

4 July 2019



SAMOFAR



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Depuis 80 ans, nos connaissances
hâtissent de nouveaux mondes



INSTITUT DE PHYSIQUE NUCLÉAIRE
ORSAY

Overview of the work realized at IPNO

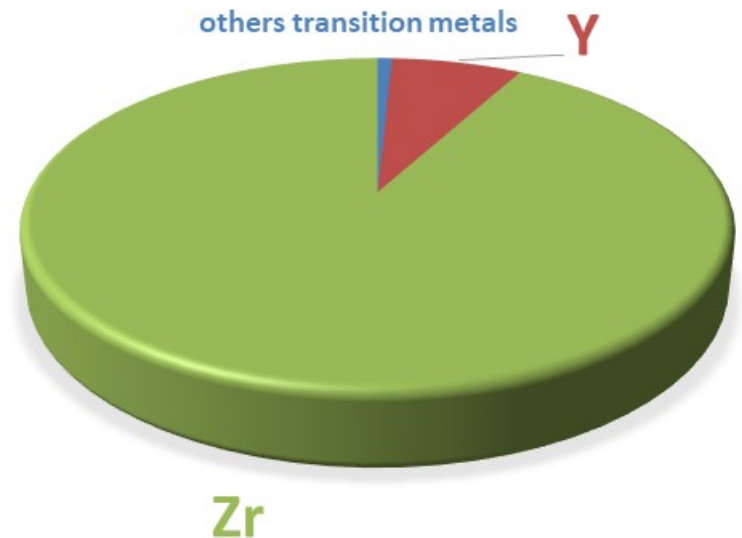
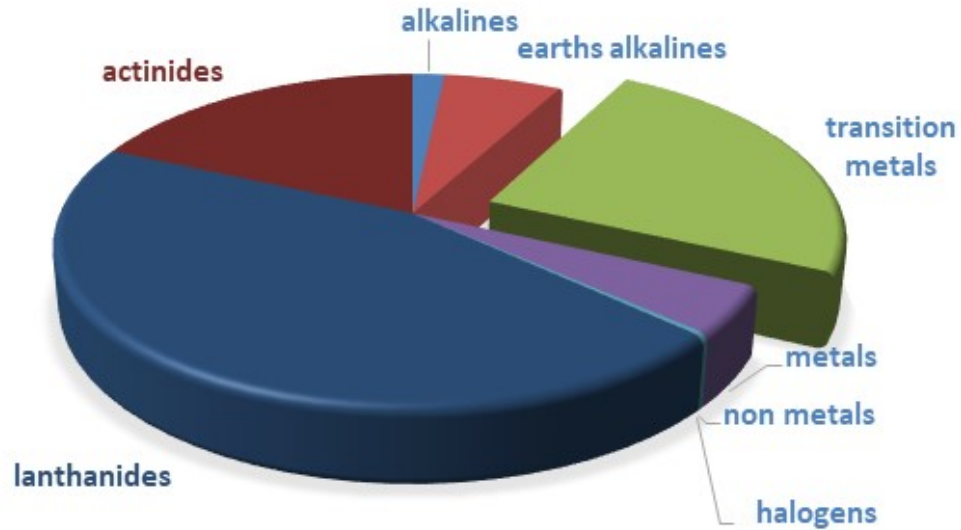
- ▶ Electrochemical behavior of uranium, iodine and zirconium in LiF-ThF_4 salt
- ▶ Synthesis of ThF_4
- ▶ Proposition of a preliminary coefficient transfert database used to calculate the decay heat in the chemical plant
- ▶ Corrosion studies of CINVESTAV samples and influence of the salt redox potential on corrosion

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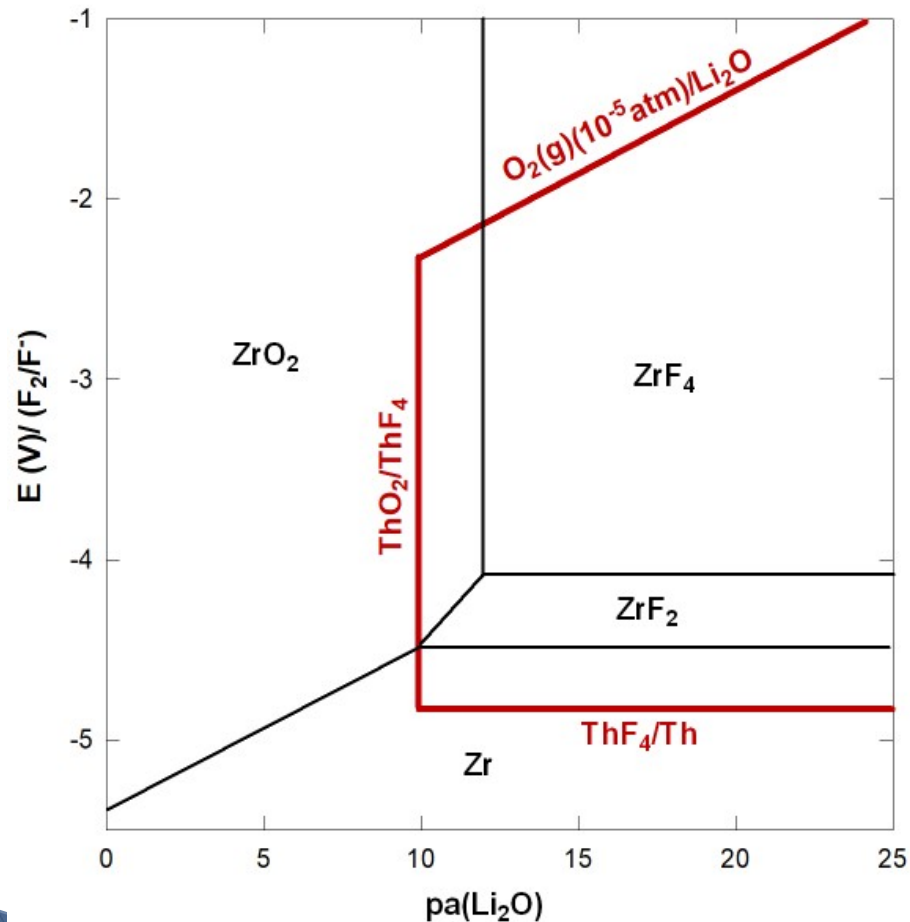
Electrochemical behaviour of Zr in LiF-ThF_4

Zr in the inventory of the MSFR core



Electrochemical behaviour of Zr in LiF–ThF₄

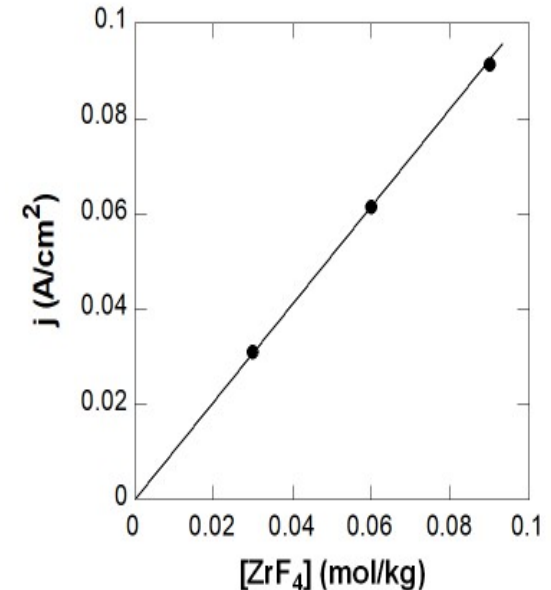
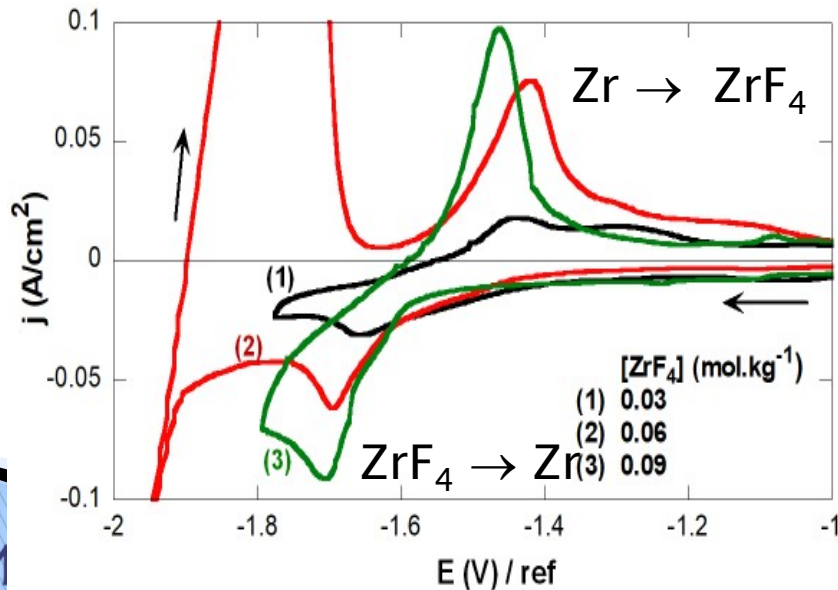
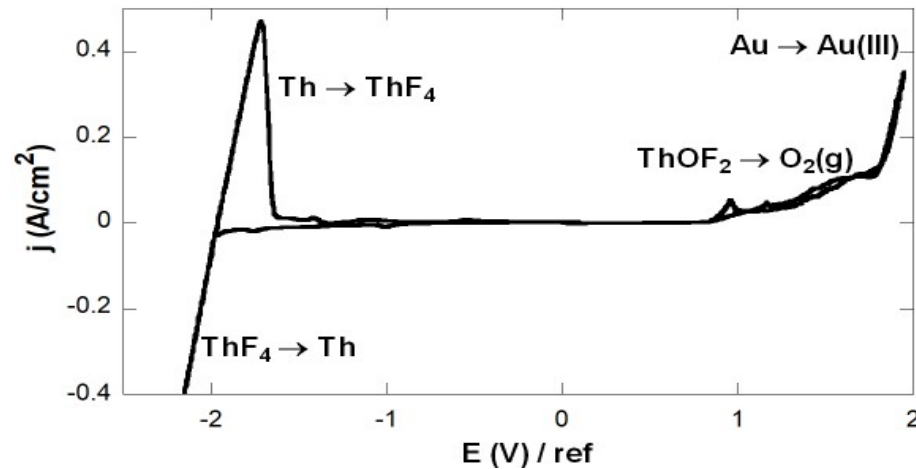
Thermodynamic calculations



- No gaseous state : Zr is not removed by He bubbling and fluorination
- Electroreduction or reductive extraction = good way but ZrF_2 can be a problem : check its stability
- Zr can be removed by precipitation of ZrO_2

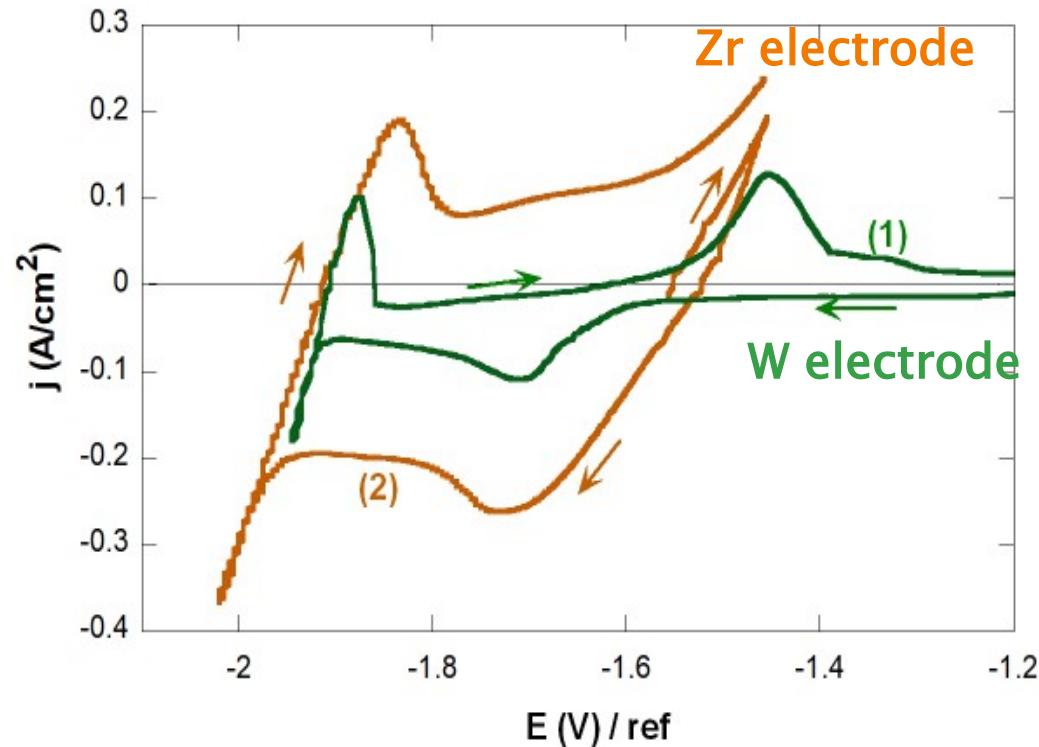
Electrochemical behaviour of Zr in LiF–ThF₄

Experimental study



Electrochemical behaviour of Zr in LiF–ThF₄

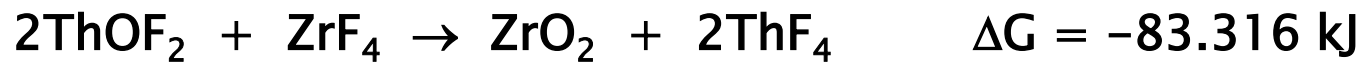
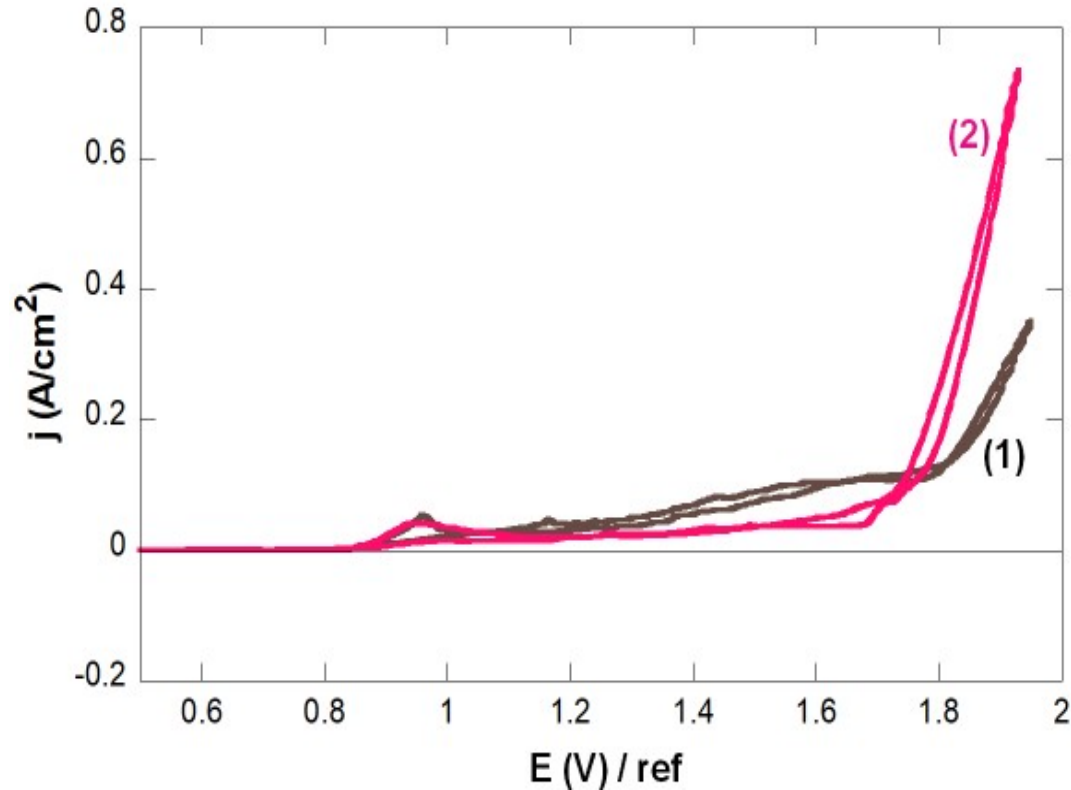
Experimental study



- ZrF₄ is the only one soluble oxidation state in LiF–ThF₄
- ZrF₄ is reduced to metal state in the electroactivity range of the fuel salt

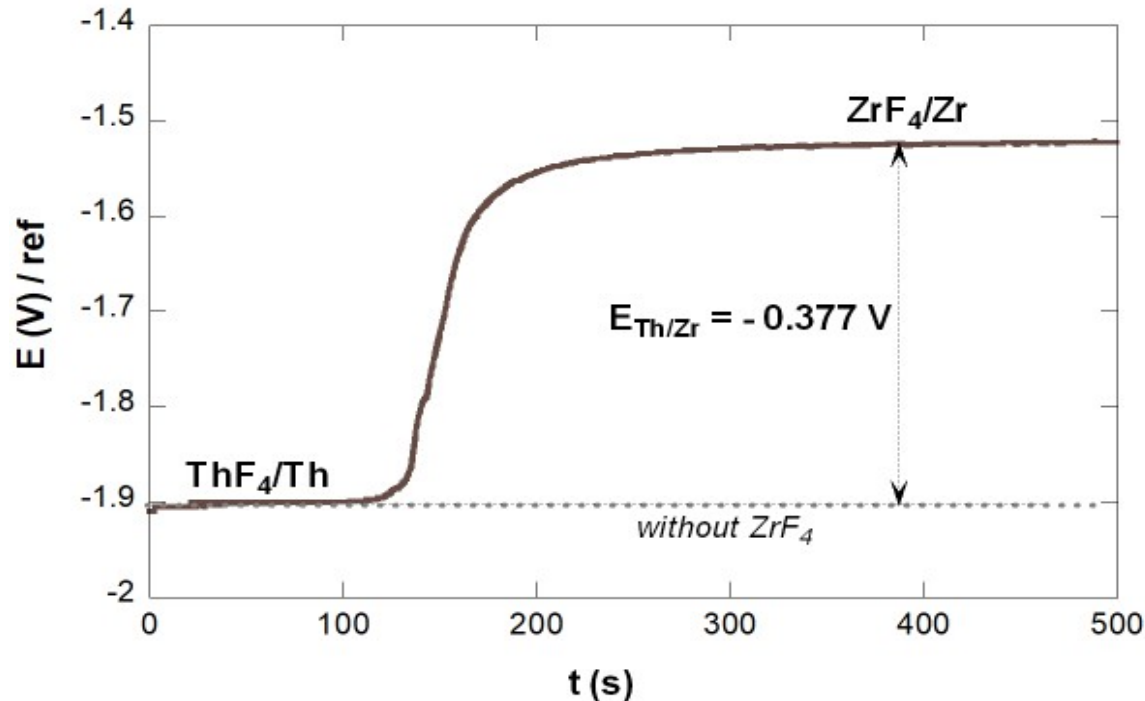
Electrochemical behaviour of Zr in LiF–ThF₄

Reactivity of zirconium with oxides



Electrochemical behaviour of Zr in LiF–ThF₄

Activity coefficient of ZrF₄

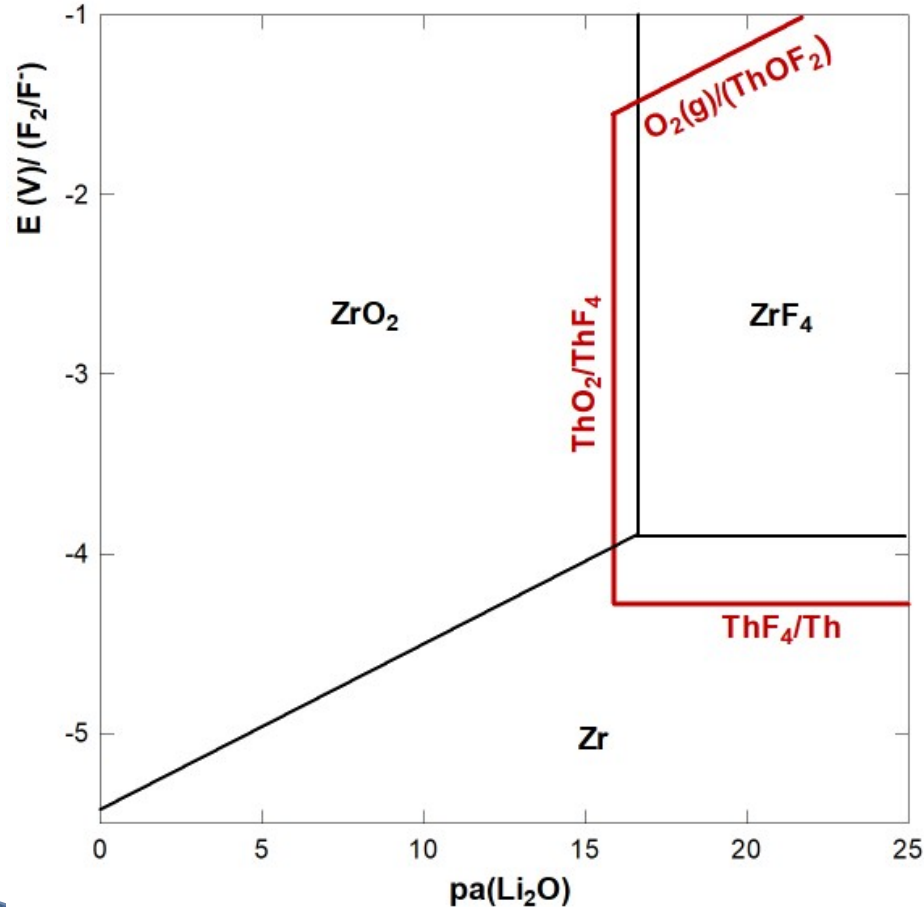


$$\log \gamma(\text{ZrF}_4) = [E_{\text{Zr/Th}} - E^\circ_{\text{ZrF}_4/\text{Zr}}] \frac{4F}{2.3RT} + 4 \log a(\text{F}^-) - \log x(\text{ZrF}_4)$$

$$\log \gamma(\text{ZrF}_4) = -4.33$$

Electrochemical behaviour of Zr in LiF–ThF₄

Conclusion



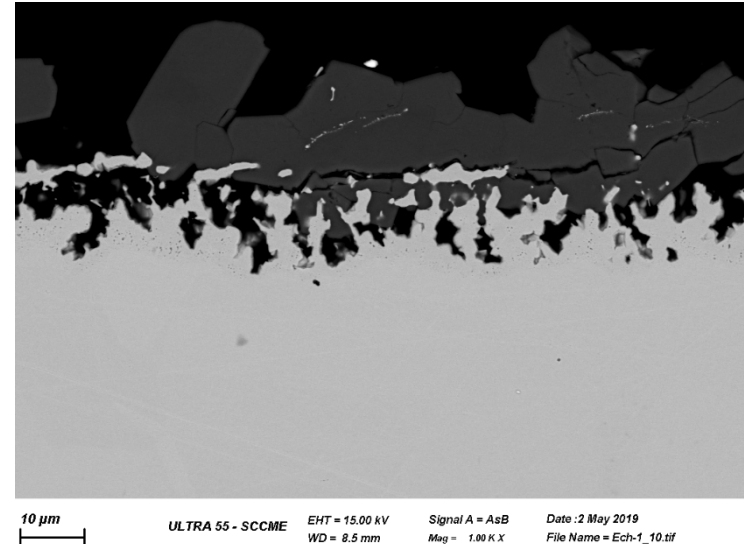
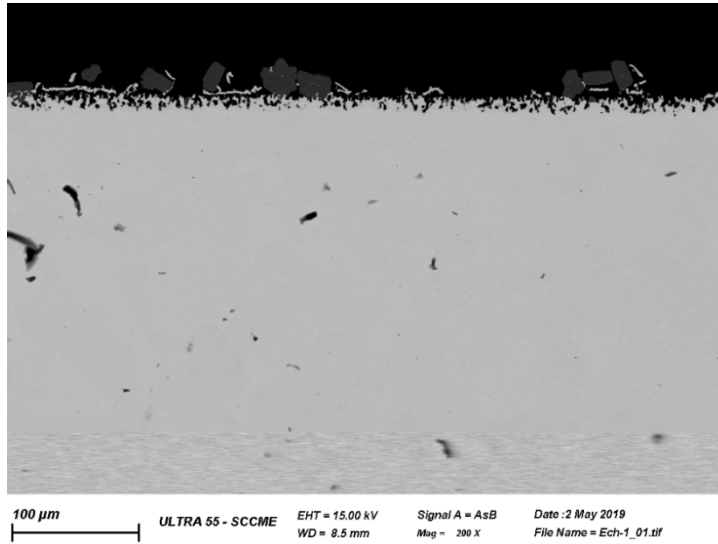
Zr can be removed from the fuel salt by electrolysis on a solid cathode before removing An and Ln by reductive extracion.

Efficiency of the extraction has to be determined by experimental measurements.

Influence of the redox potential on the corrosion

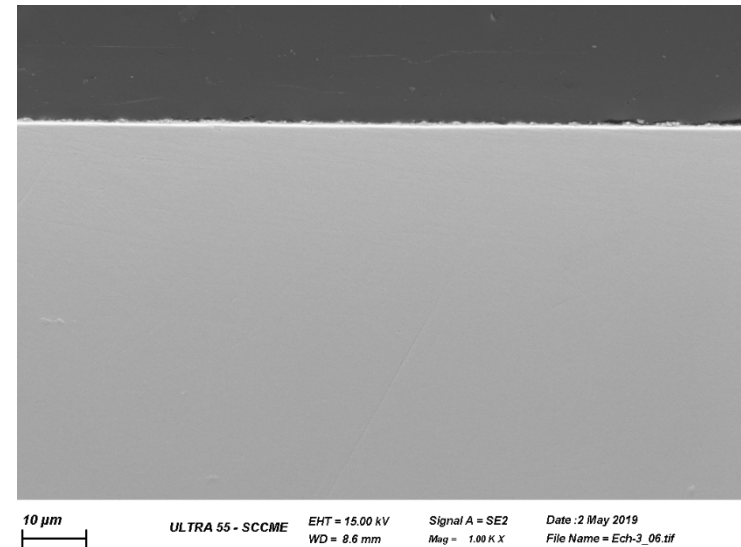
Hastelloy C276

Without E control



*2 weeks immersion in a
mixed chloride-fluoride
salt at 600°C*

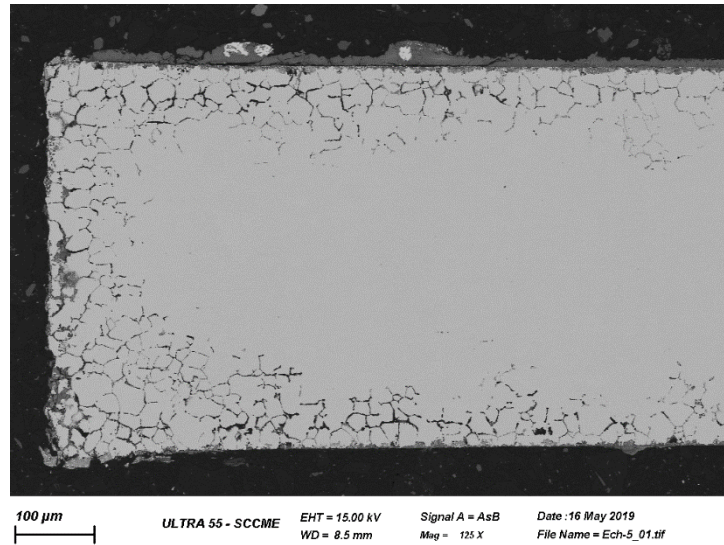
With E control



Influence of the redox potential on the corrosion

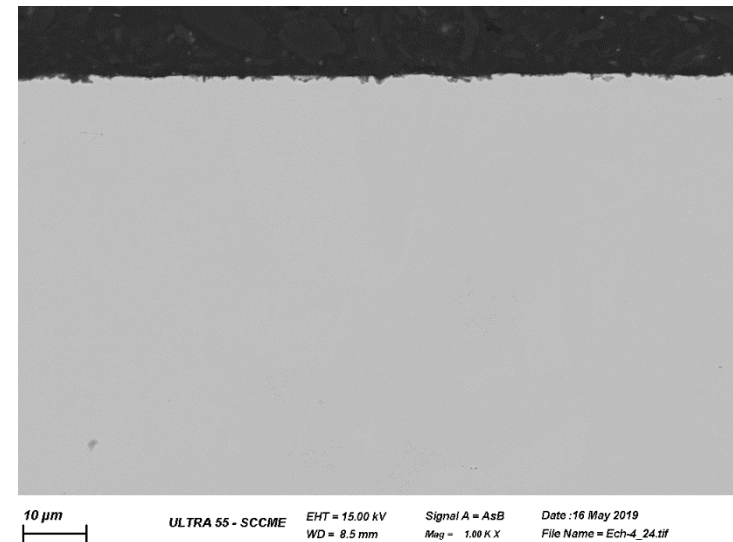
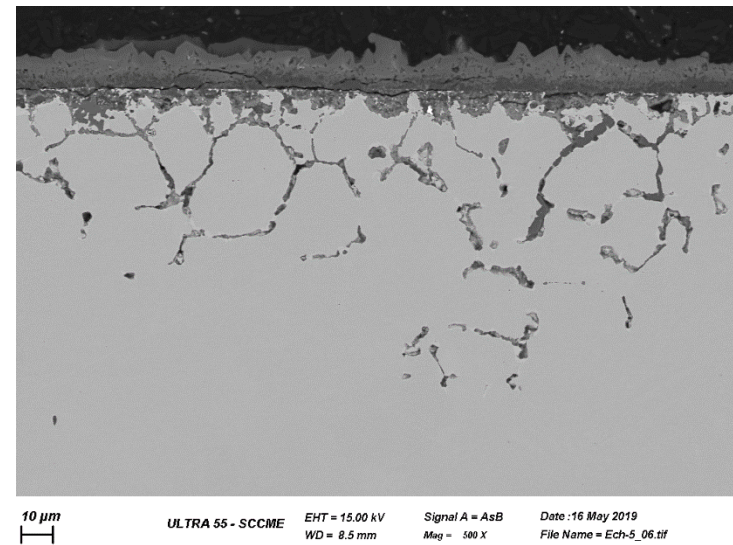
Stainless steel AISI 304

Without E control



*2 weeks immersion in a
mixed chloride-fluoride
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With E control



Thank you for your attention

