PHYSICAL AND CHEMICAL CHARACTERIZATION OF A DEPOSIT OF CHROMIUM OXIDE

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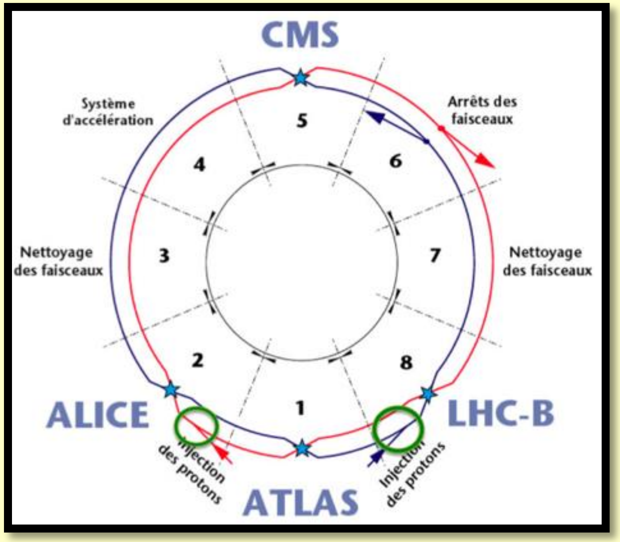
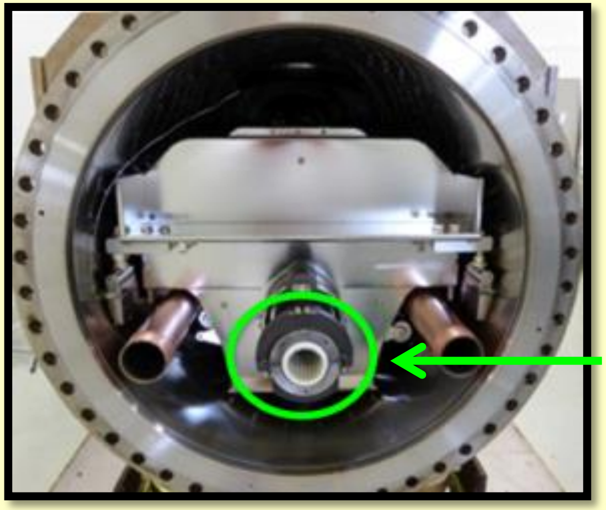
Table of contents

• Injection Kicker Magnets

- electromagnetic devices composed of 4 magnets and 4 pulse generators
- guide, maintain and focus the particle beam on its near-circular orbit
- installed on the injection points of LHC
- 0,12Tesla in less than 900ns, for about 8ms.

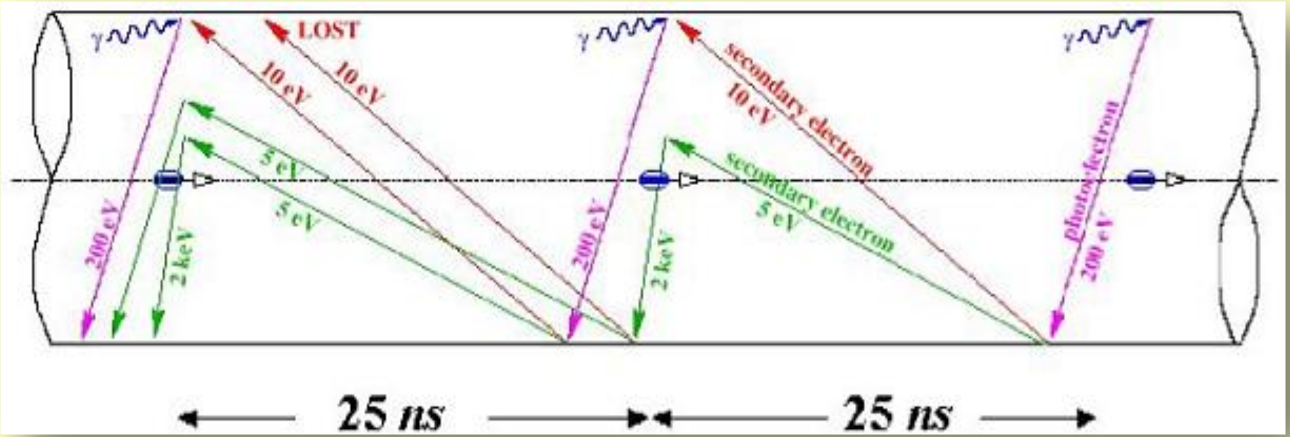




Introduction

- <u>Problem with electron clouds</u>

- vacuum chambers in alumina
- high SEY **~ 9-10**



(by F. Ruggiero)

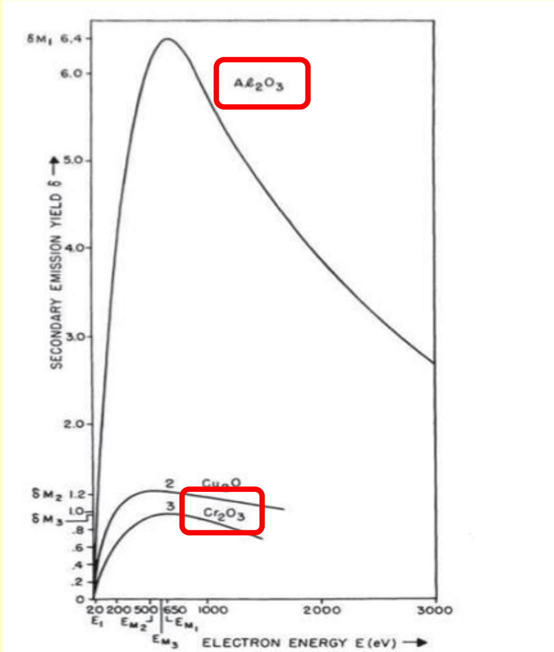
- adverse effects: →increase in pressure
  →rise of temperature of the cold magnets
  →instabilities, loss of beam.

Introduction

- **Topic of the internship**

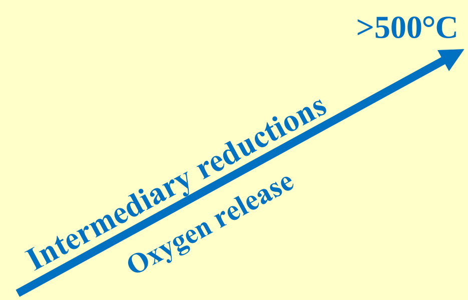
FINAL AIM: SEY reduction **1,4**

- Mike Barnes (TE-ABT-FPS)



Secondary-electron yield curves for Al_2O_3 (Dawson [7]) and Cr_2O_3 and Cu_2O.

CrO_3
Cr(VI)



Cr_2O_3
Cr(III)

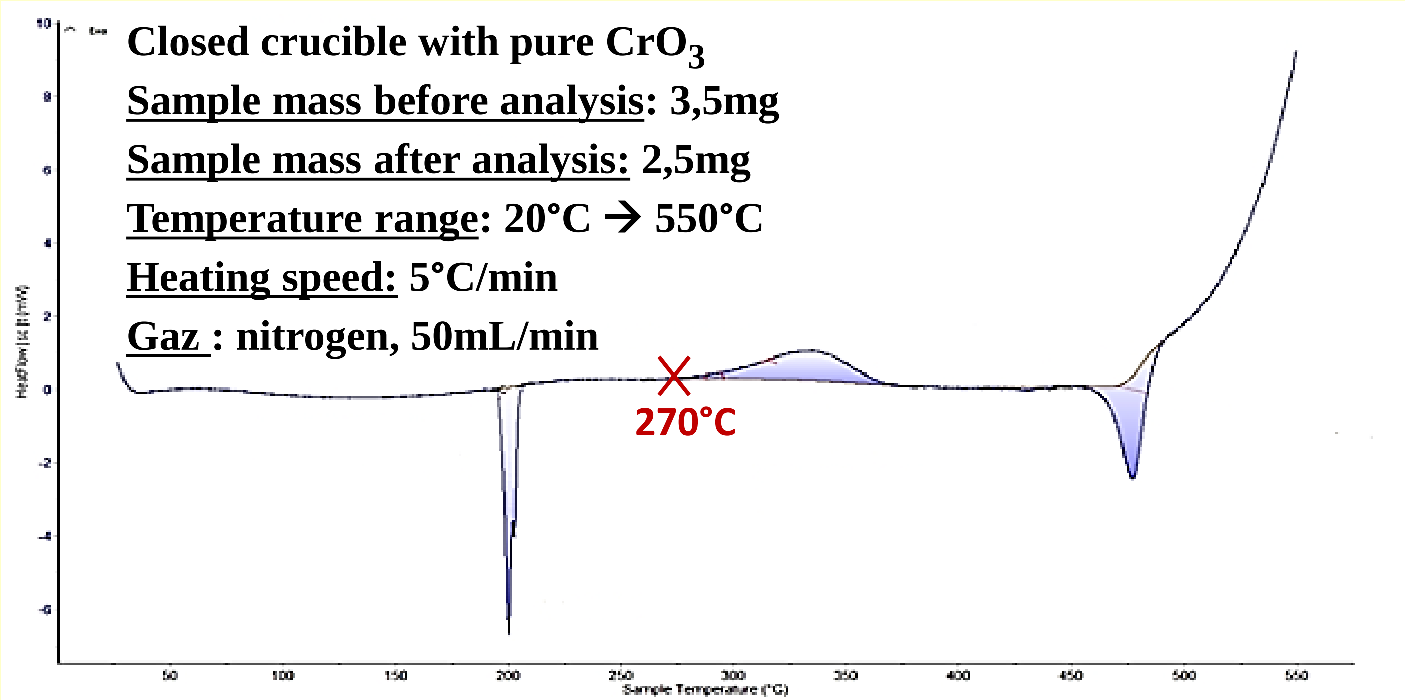
Dr. Sudarshan, The Effect of Chromium Oxide Coatings on Surface Flashover of Alumina Spacers in Vacuum (1976).

- Objectives:
  1. Establishment of analysis methods
     - FT-IR spectroscopy
     - Thermal analysis
     - X-Ray diffraction (EN-MME-MM)
     - SEY measurements
  2. Heat treatments at different temperatures.

Establishment of the analytical methods and parameters

Thermal Analysis

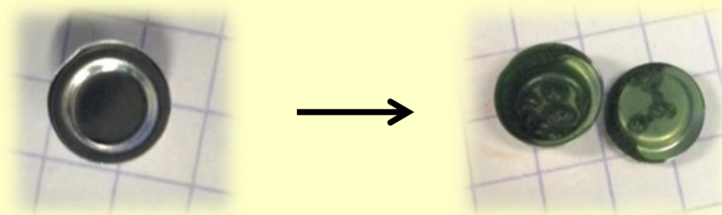
- Differential Scanning Calorimetry

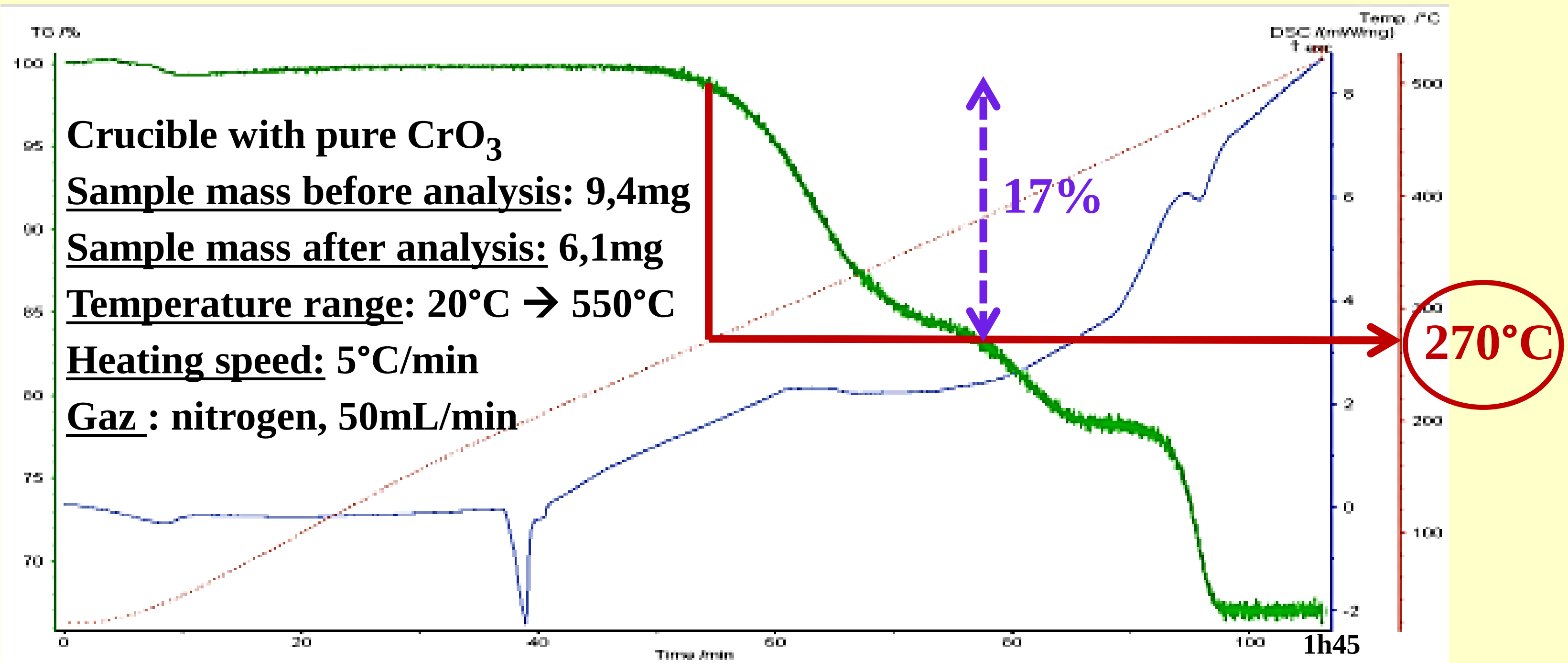


Total mass loss: **30%** > **23%** (theory: $4CrO_3 \rightarrow 2Cr_2O_3 + 3O_2$)

Evaporation?

- Thermogravimetry



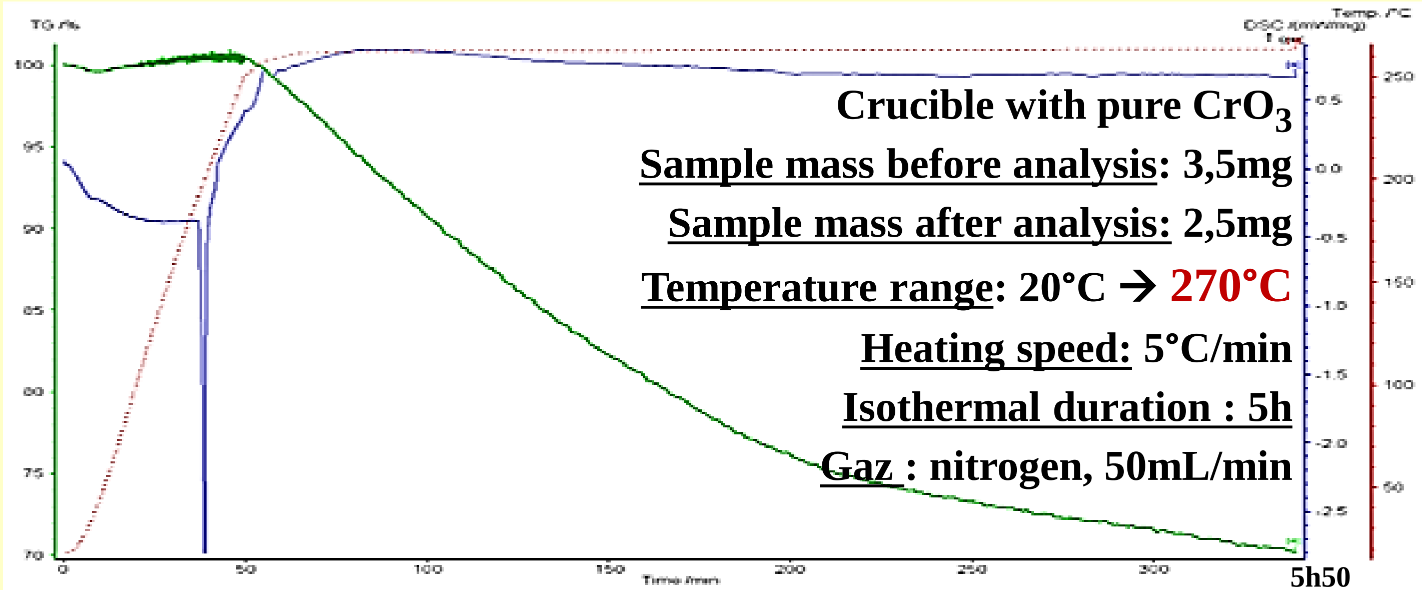


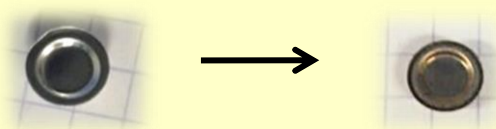
Total mass loss: **35% > 23%**

Evaporation?

Mass loss (1st reaction): **≈17%**

Thermal Analysis





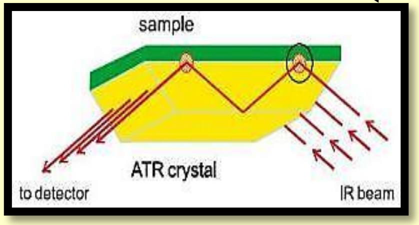
Total mass loss: **30% > 17%** **Reaction + Evaporation?**

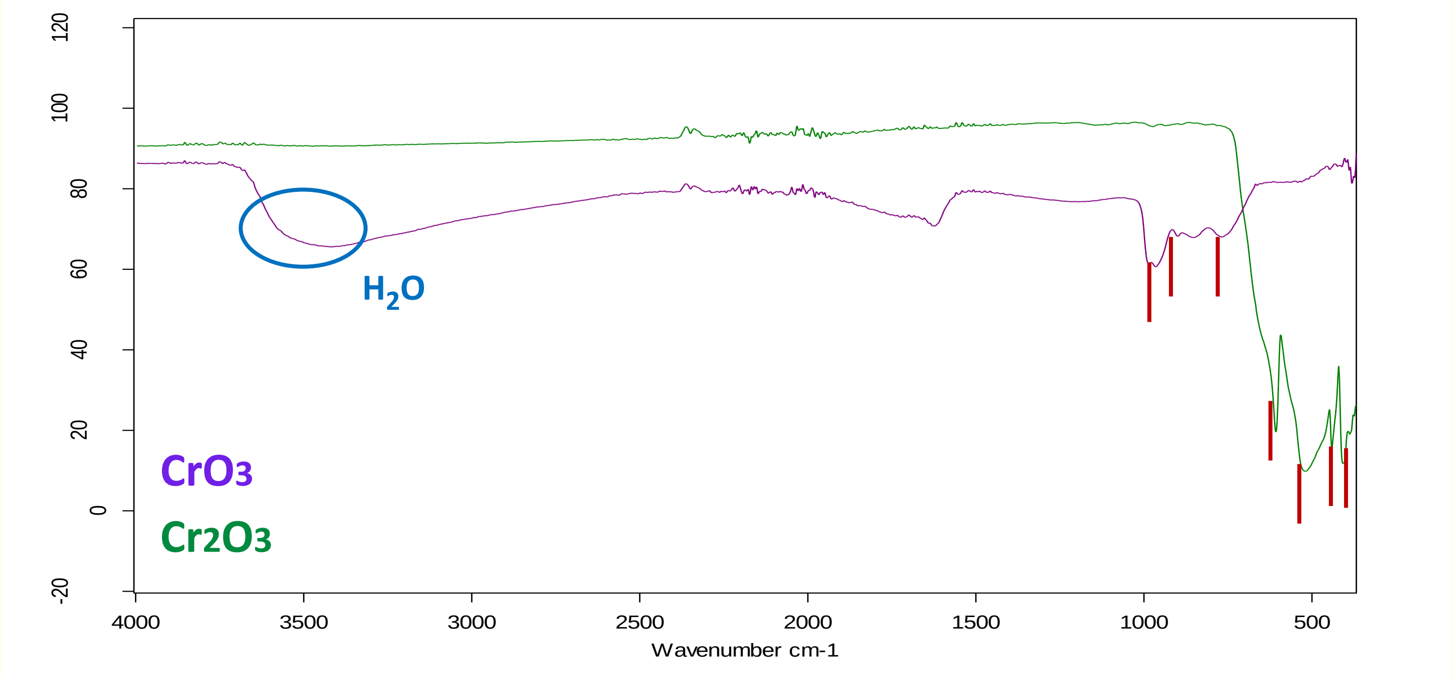
→ Characterisation of the Cr(VI) thermal reduction.

→ Restart of the thermobalance.

FT-IR Spectroscopy

- <u>Attenuated Total Reflectance (ATR)</u>



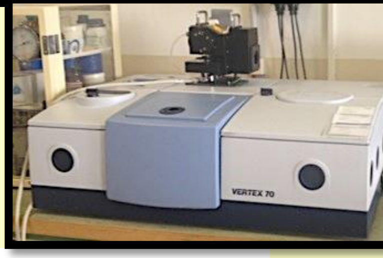


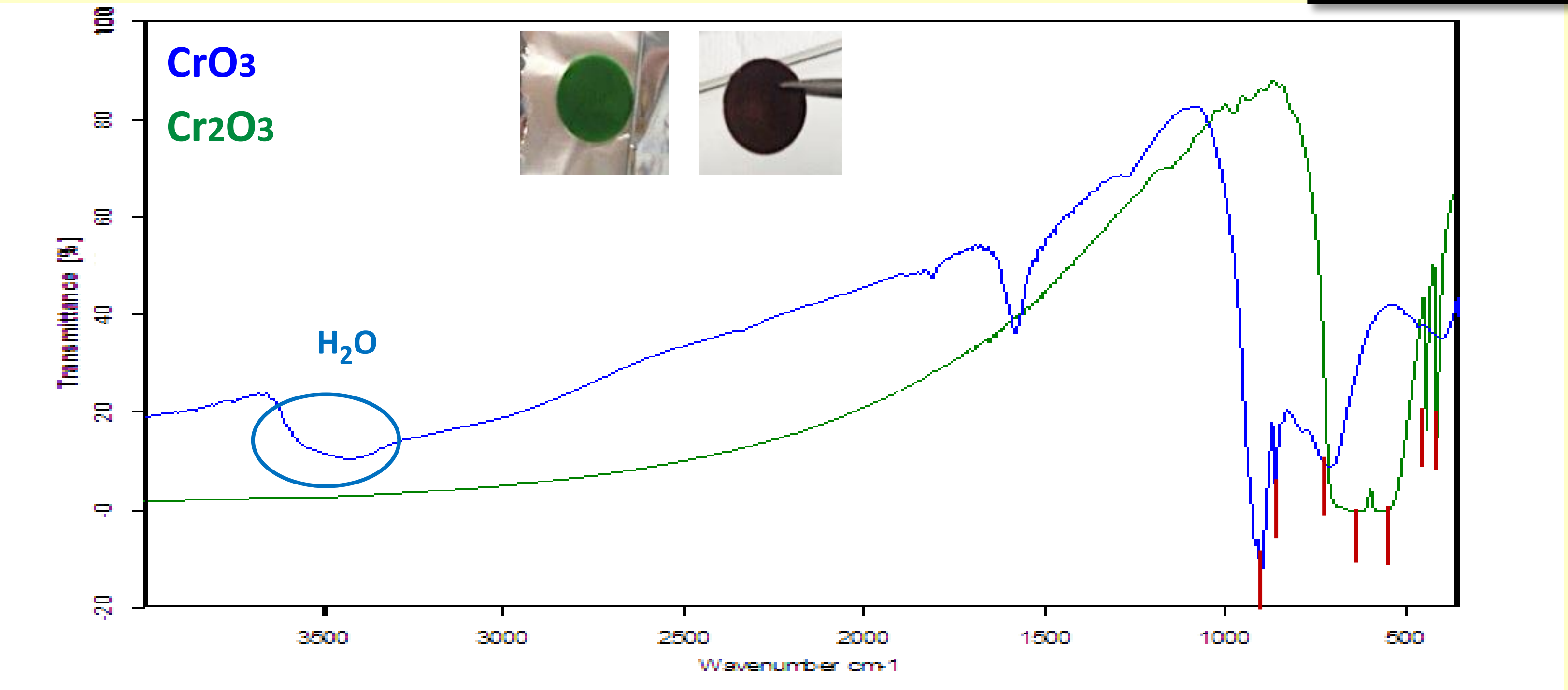
+ Fast, non-destructive.

- Unsuitable for in-situ analysis in vacuum chambers.

FT-IR Spectroscopy

- <u>Transmission</u>





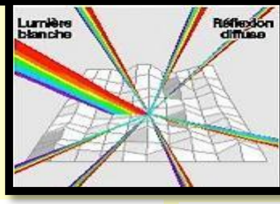
+ Suitable for in-situ analysis.

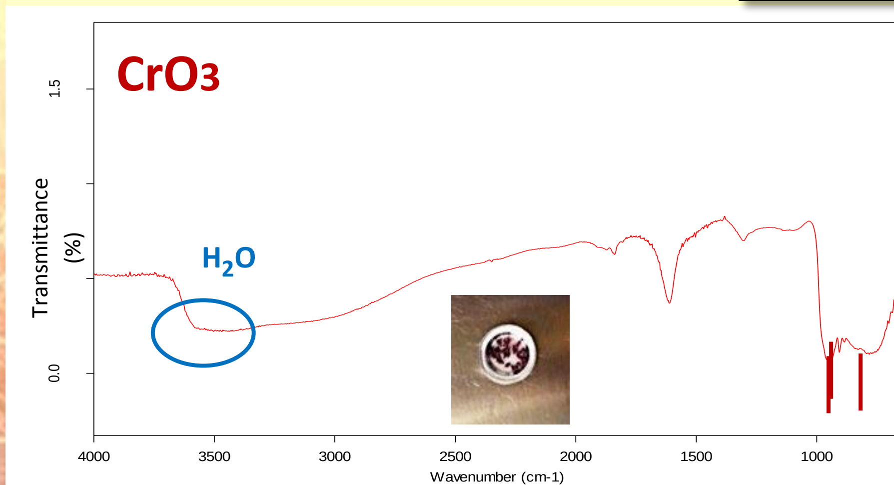
Characterisation of the oxides.

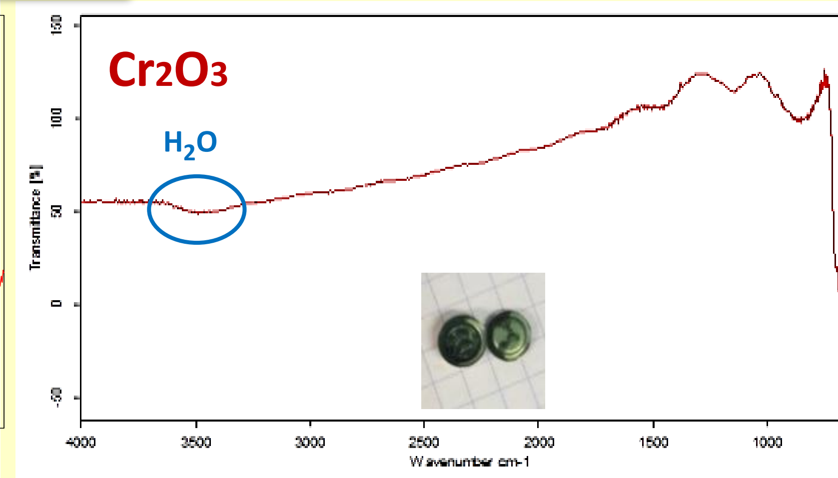
- Samples storage (CrVI and KBr hygroscopic).

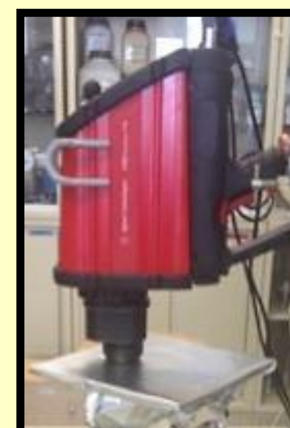
FT-IR Spectroscopy

- Diffuse Reflectance







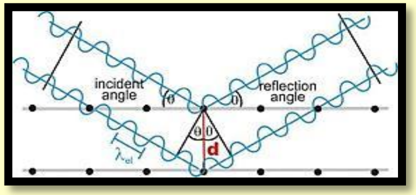


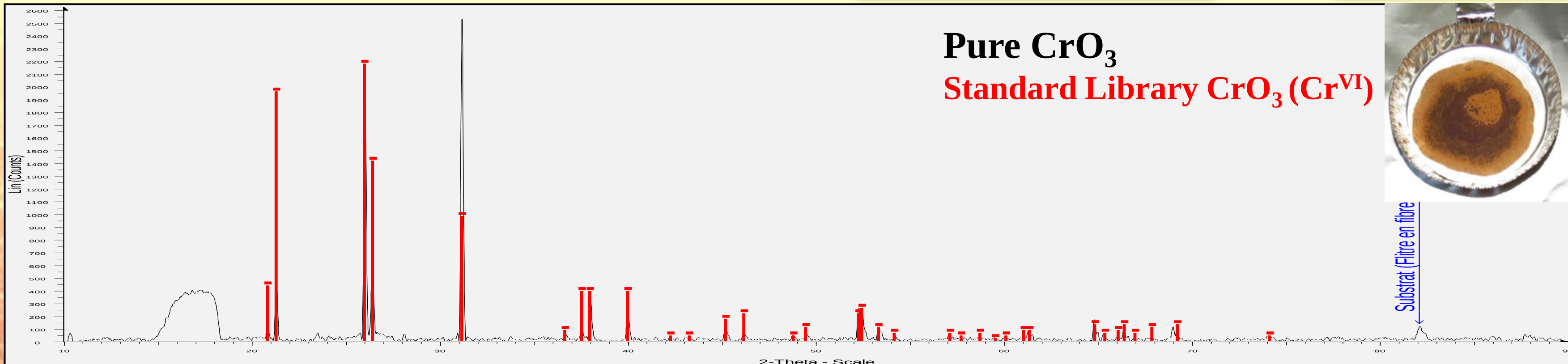
+ Suitable for analysis of residues in crucibles.
  Characterisation of the oxides.

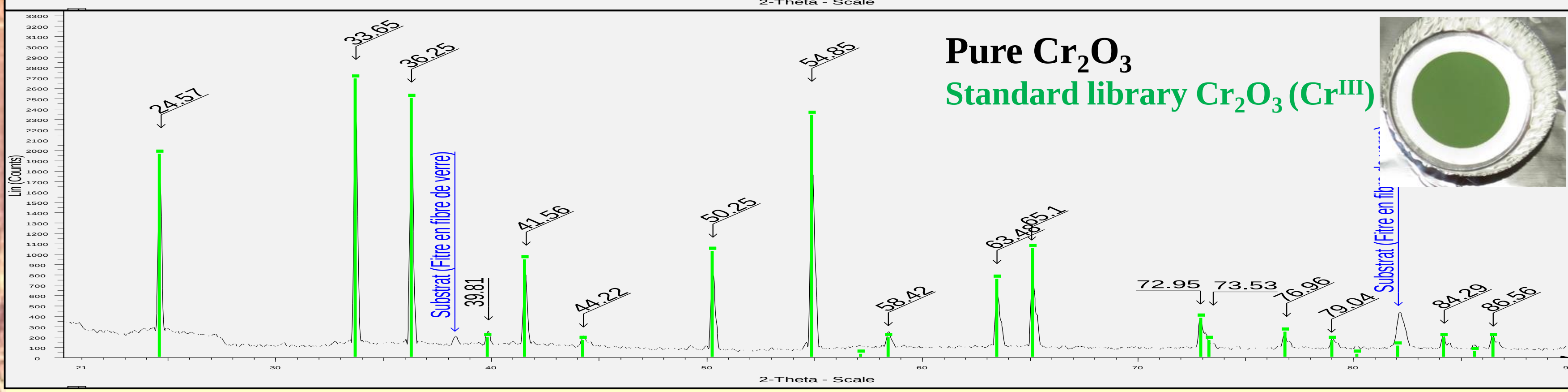
- Apparatus limitation (minimum wavelength: 600cm-1).

→ **Characterisation of the chromium oxides.**

X-Ray Diffraction







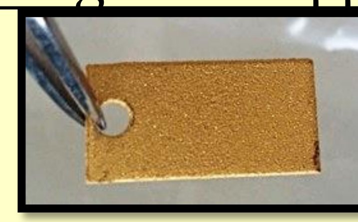
(Floriane Leaux, Gonzalo Arnau Izquierdo (EN-MME-MM))

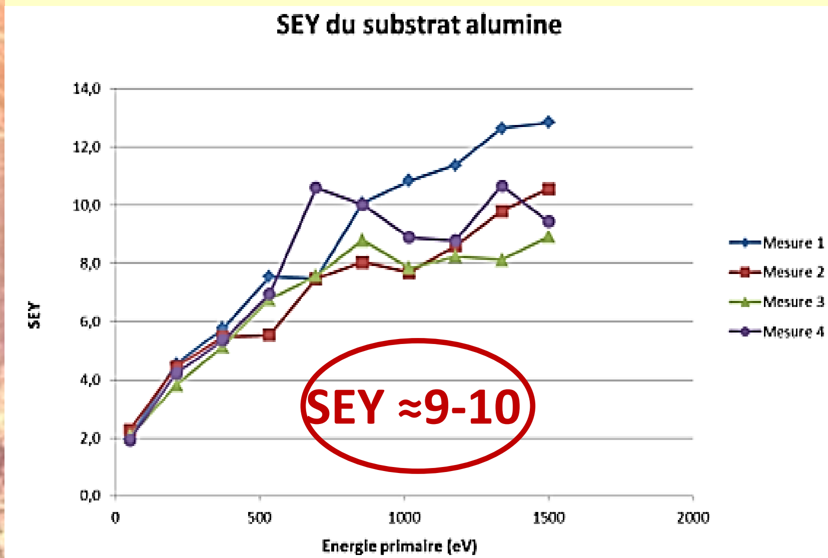
→ Characterisation of the chromium oxides.

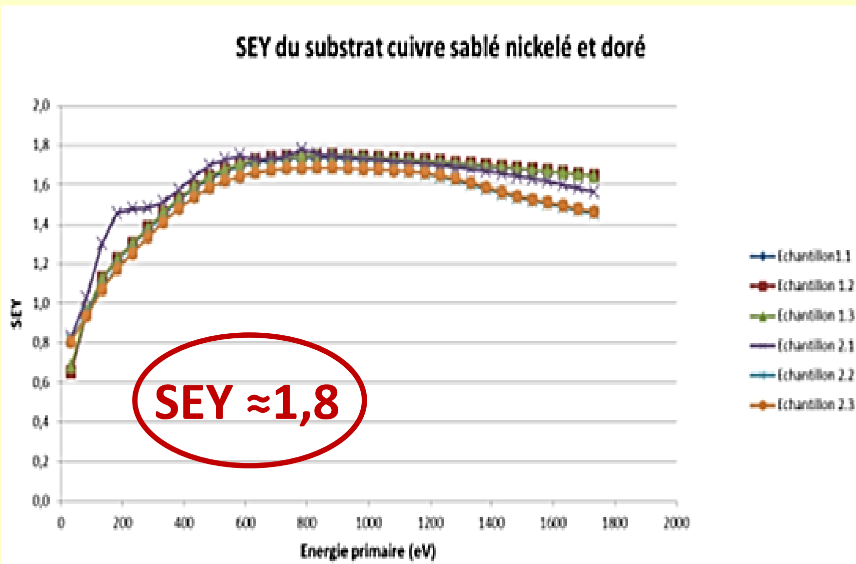
SEY Measurements

- Alumina

- Sand-blasted, nickel-coated and glided copper







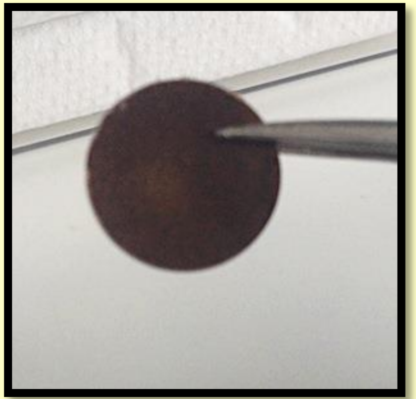
(Holger Neupert, Valentin Nistor (TE-VSC-SCC))

Heat treatments

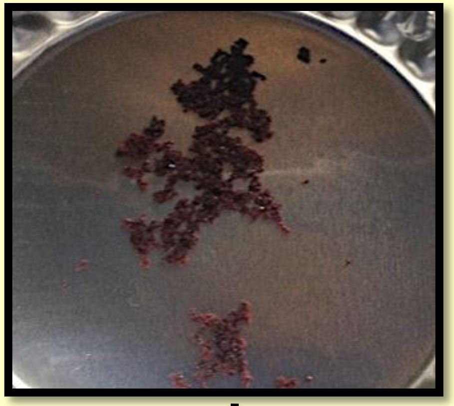
Samples before treatment

$CrO_{3(aq)}$ 10% (w/w) coating (Cr(VI))

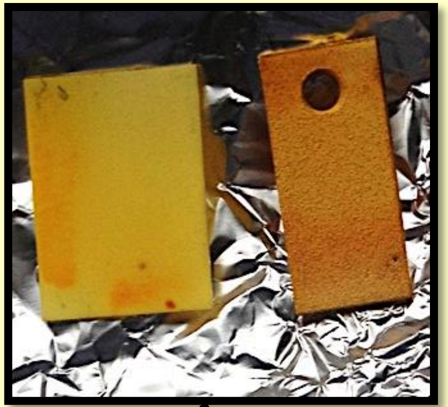
(1h dipping + 1h drying (120°C))



FT-IR spectroscopy

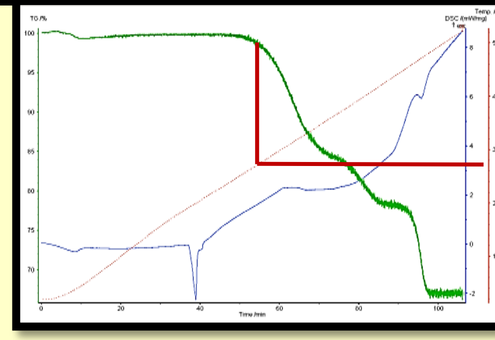


X-Ray diffraction

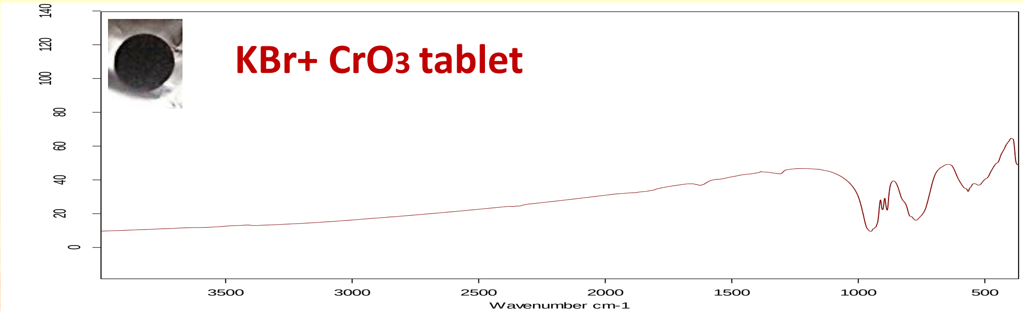


SEY measurements

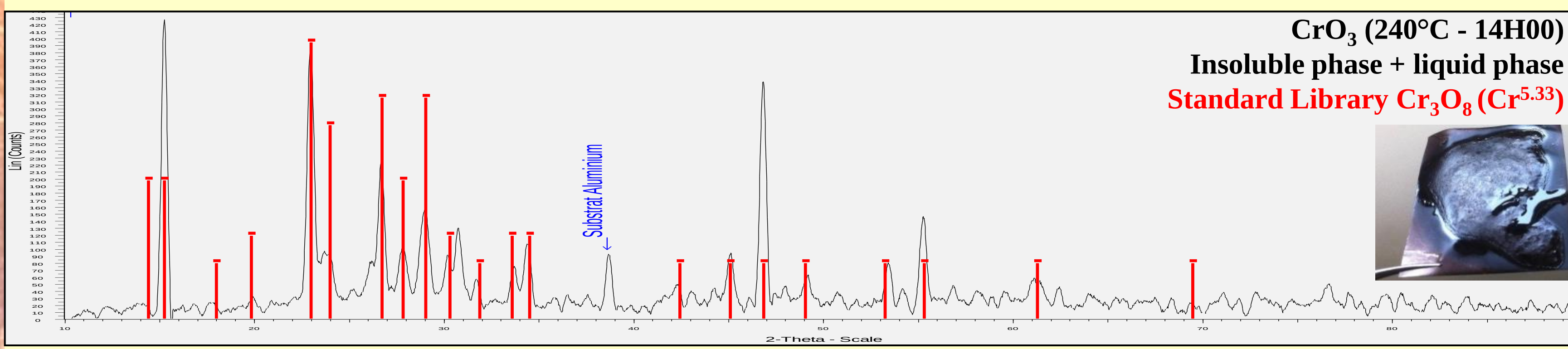
260°C for 4hours



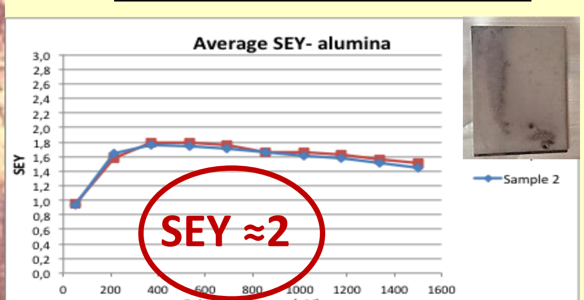
- ## FT-IR spectroscopy

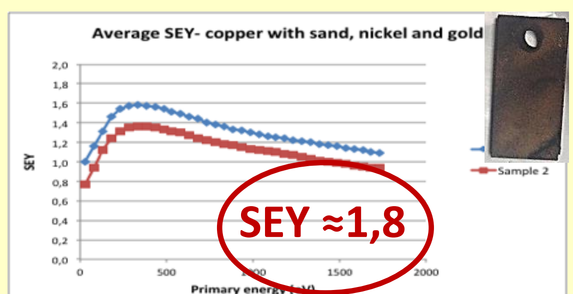


- ## X-Ray diffraction *(EN-MME-MM)*



- ## SEY measurements

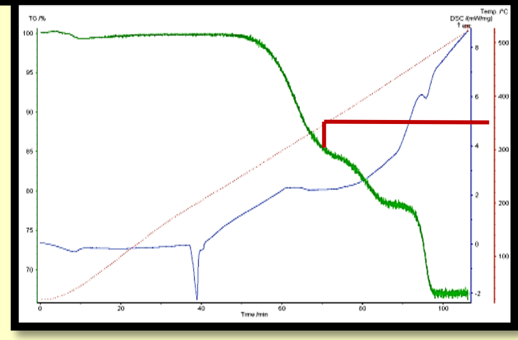




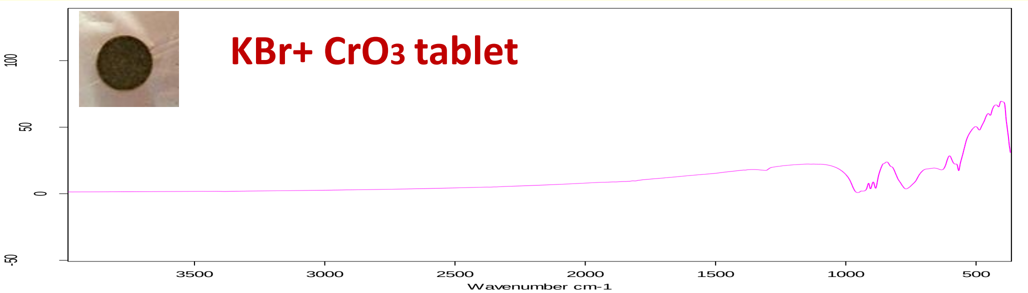
→ **Decrease in SEY.**

→ **Inapplicable solution (hydroscopic).**

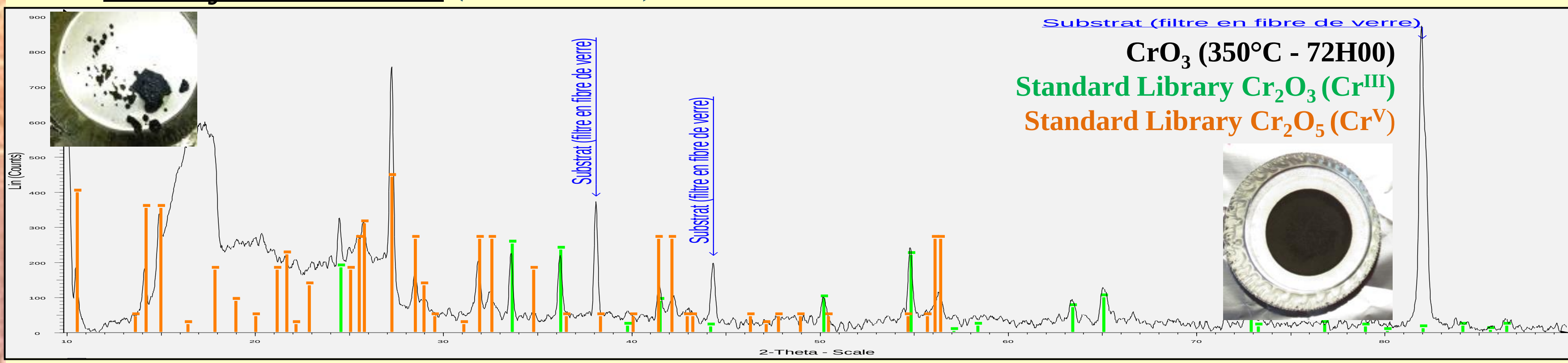
350°C for 72hours (backout simulation)



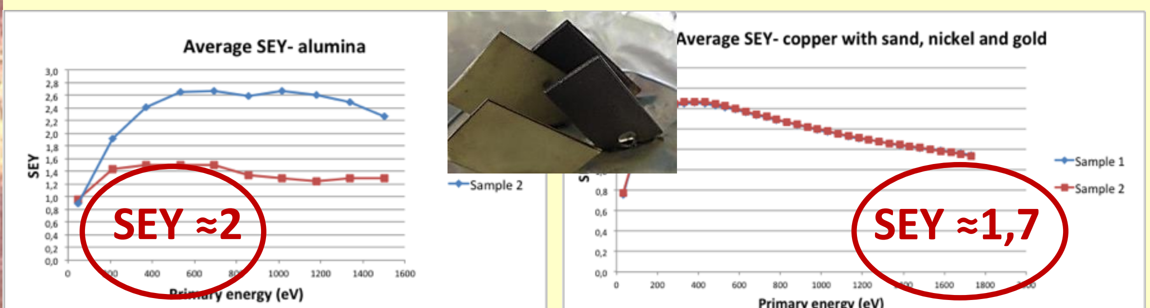
- FT-IR spectroscopy



- X-Ray diffraction *(EN-MME-MM)*

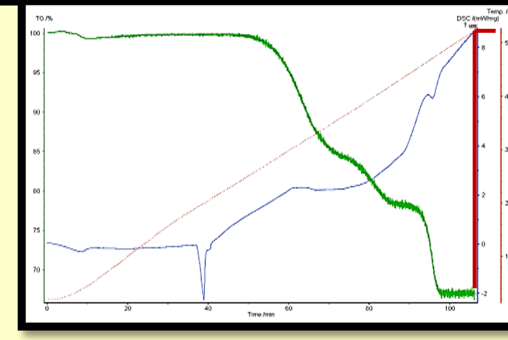


- SEY measurements

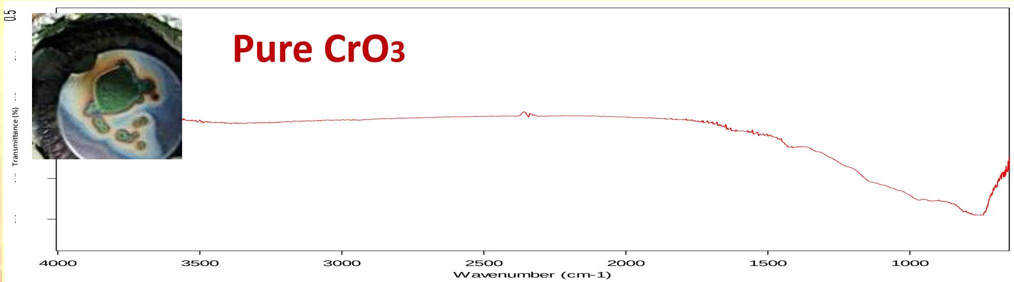


→ Creation of Cr(III).
→ Unstable solution.

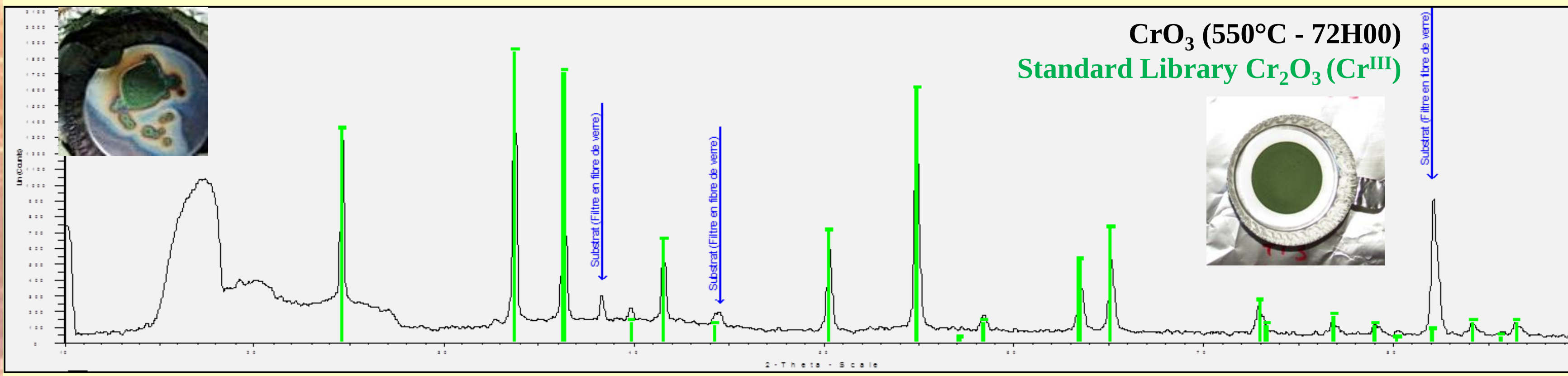
550°C for 72hours



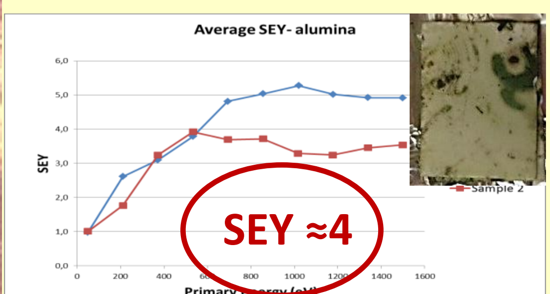
- FT-IR spectroscopy

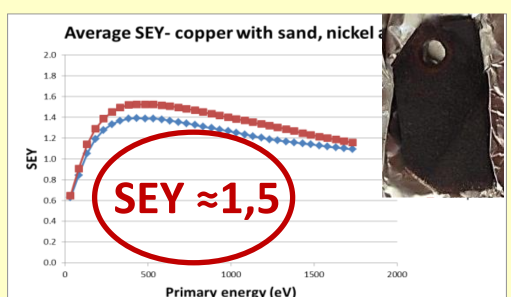


- X-Ray diffraction *(EN-MME-MM)*



- SEY measurements





→ Inhomogeneous coating.

→ Presence of Cr(III).

Conclusions

- Analytical methods and parameters established.
- Several solutions to control coatings in the vacuum chambers.
- Cr(III) seems to be a stable solution.

Improvements:

- Study homogeneity of the coatings.
- Identify intermediary oxides, create a FT-IR data base.
- Study the influence of number of backouts for the Cr_2O_3 concentration.

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