The ‘complex’ route to sustainable Cr(VI)-free steel plating

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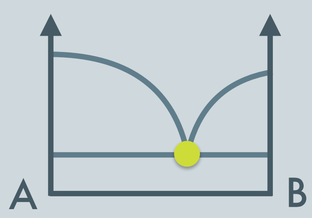
1 - INTRODUCTION

- In various industries, steel components need to be protected from the harsh conditions
- Very often, this is done by coating the components with a **hard chromium layer**
- The layer is typically electrodeposited from an aqueous solution containing the **toxic and carcinogenic Cr(VI)**
- **OCAS NV** is working on a **sustainable** Cr(VI)-free alternative, using a patented Cr(III)-based deep-eutectic solvent (DES) as electrolyte[1]. However, there still exists a lack of fundamental knowledge on the deposition mechanism
- This project focuses on the elucidation of the **coordination chemistry** of the Cr(III)-species in the DES as a function of composition and the presence of additives to predict the in-use properties of the hard chromium layer.

2 - GOAL

- ‘Pure’ absorption spectra of all possible Cr(III) species which are expected in various DES
- Use of these model spectra to study the DES in more detail

Cheap ionic liquid alternative



Deep-eutectic solvent

Quaternary ammonium salt

+

Hydrogen bond donor or metal salt

| $CrCl_3 \cdot 6H_2O$

3 - RESULTS

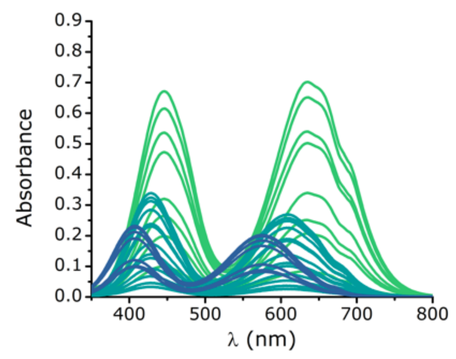
UV/Vis model spectra were obtained from **literature**[2], by **ion exchange chromatography** and **MCR-ALS**[3].

Philip Elving synthesized 3 (+1) possible Cr(III) complexes in acidic solutions and recorded the UV/Vis spectra[2]:

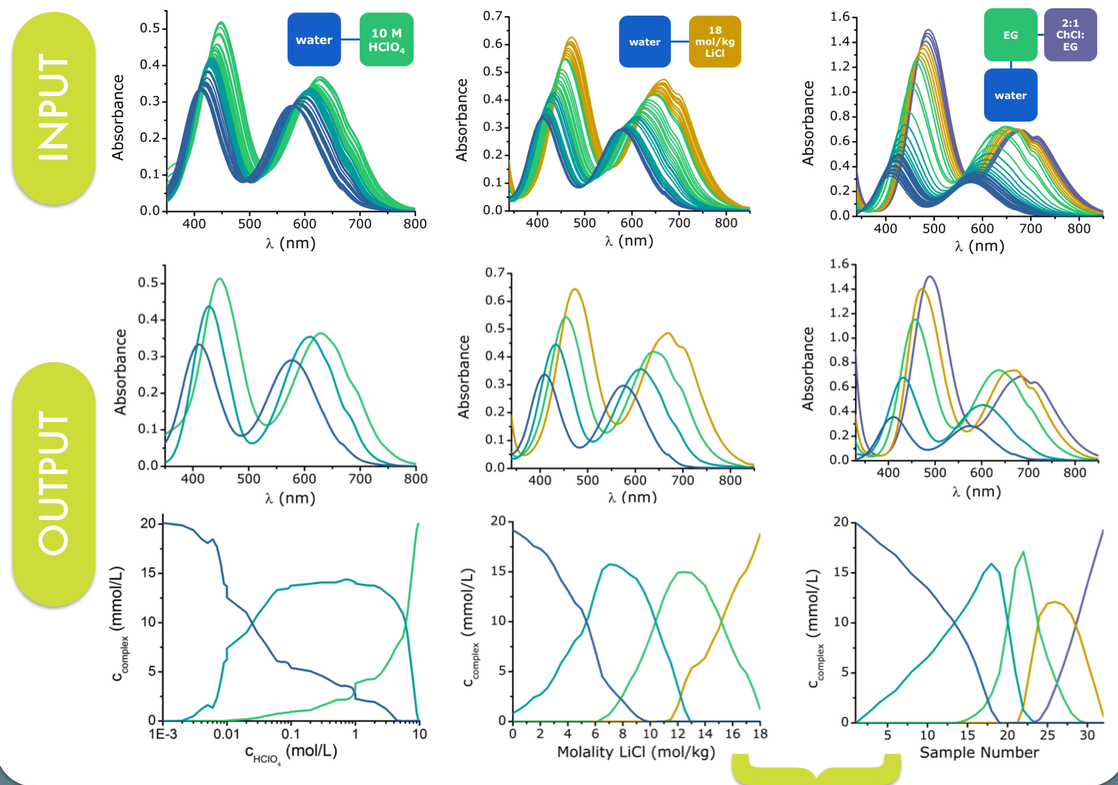
407 nm	430 nm	450 nm	475 nm
575 nm	605 nm	635 nm	665 nm

?

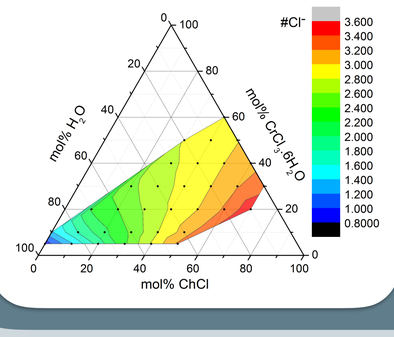
Pure spectra of Cr(III) complexes from acidic aqueous solutions by **ion exchange chromatography**



Multivariate Curve Resolution Alternating Least Squares (**MCR-ALS**)[3]:

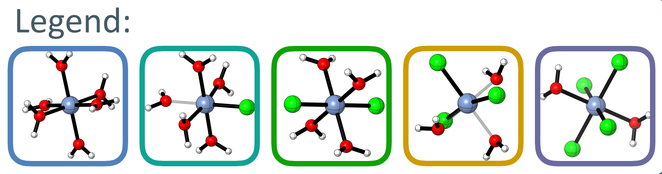


Application: “Ternary Coordination Diagram”



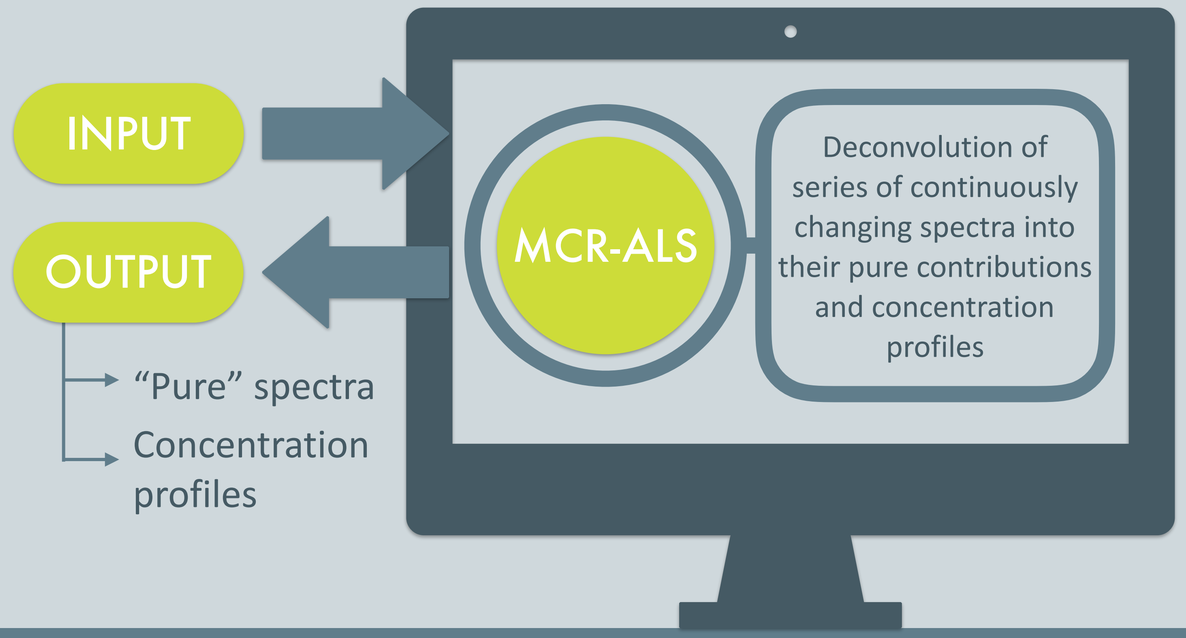
Also studied by **EXAFS**

Legend:



Average peak maxima of every complex:

410 nm	431 nm	452 nm	474 nm	489 nm
576 nm	608 nm	635 nm	670 nm	684 nm



1. Abbott, A. P., Frisch, G. & Ryder, K. S. Electroplating Using Ionic Liquids. *Annu. Rev. Mater. Res.* **43,** 335–358 (2013).
2. Elving, P. J. & Zemel, B. Absorption in the Ultraviolet and Visible Regions of Chloroaquochromium(III) Ions in Acid Media. *J. Am. Chem. Soc.* **79,** 1281–1285 (1957).
3. Jaumot, J., de Juan, A. & Tauler, R. MCR-ALS GUI 2.0: New features and applications. *Chemom. Intell. Lab. Syst.* **140,** 1–12 (2015).

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