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RareEarth
GREEN MINING AND SEPARATION

Controlling the Rare Earth Molten Salt Electrolysis with Reduced PFC Emissions

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> Introduction

Reference: Reuters.com, 2015

Neodymium electrolysis about 30.000 t/a

Reference: sh-huke.com, 2015

Nd metal

Reference: Siemens 2011

Magnets in e. g. power generators

> Motivation / Approach

Emission from electrolysis

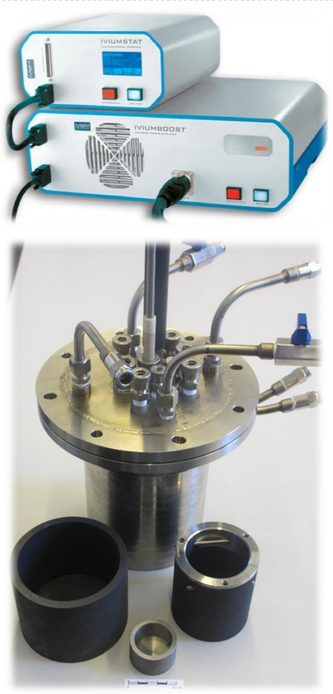
- Only CO_2: ~ 0,4 kg CO_2-equiv./kg_{Nd}
- Continuously CF_4 (10%): ~ 340 kg CO_2-equiv./kg_{Nd}
- Comparison: Al electrolysis: ~ 2 kg CO_2-equiv./kg_{Al}

Process control strategy to avoid PFC emission

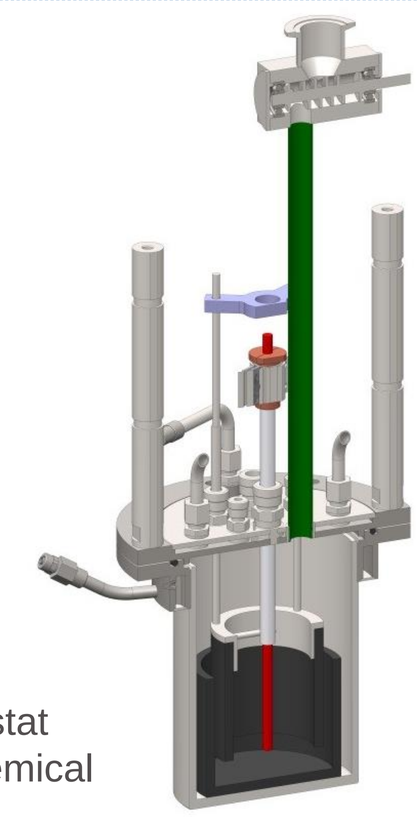
- Keep voltage in save process window → under fluoride deposition and without anode effect happening
- Determine dependence of cell resistance from oxygen concentration and potential
- Automate process with controlled oxide feeding

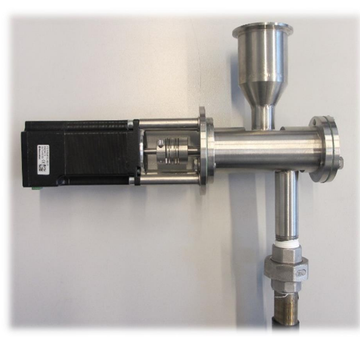
> Experimental setup

FTIR gas analyser;
every two sec. precise concentration measurement of all relevant gases



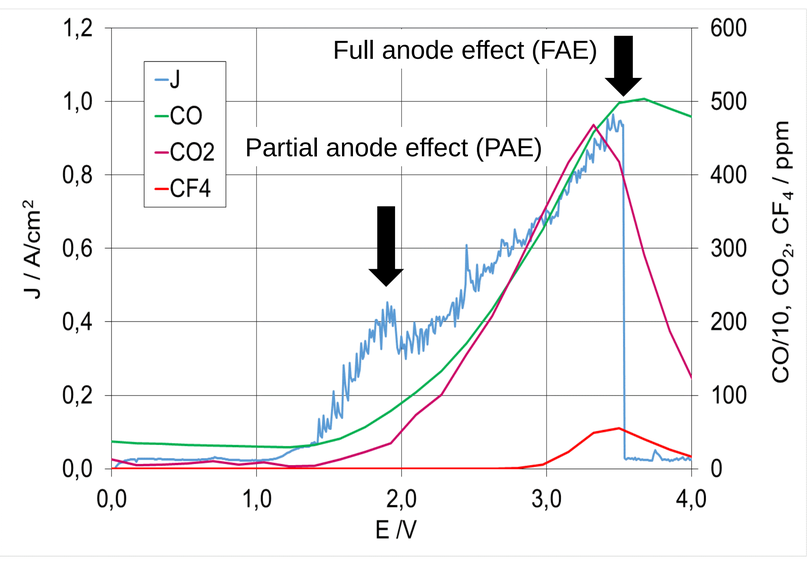
Laboratory cell with 10 A potentiostat and booster for precise electrochemical measurements at 1050 °C





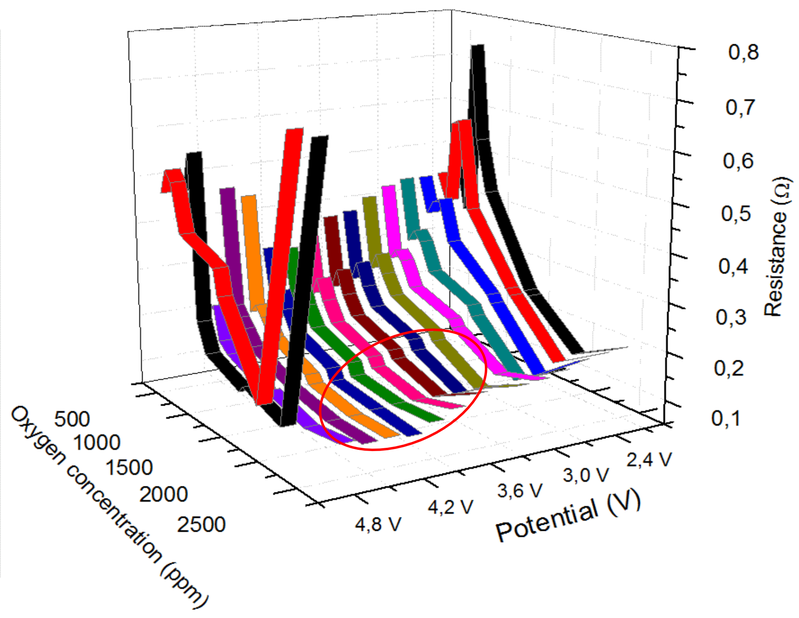
Cell with 200 A rectifier and 2,2 kg electrolyte (NdF_3 87,5 wt%; LiF 12,5 wt%) constructed like the industrial cell with a vertical ring cylinder graphite anode and rod tungsten cathode. Custom developed oxide dosing system activated automatically by the control unit.

> Results



With partial anode effect CF_4 emission starts with traces of C_2F_6

Critical current densities (CCD) of PAE depend mainly on oxygen concentration, while CCD of FAE depend mainly on voltage



Pseudo cell resistance in relation to the oxygen concentration and the cell voltage. In general: the lower the oxygen concentration, the higher the resistance

> Conclusion

- Anode effect is a serious environmental issue
- Similar relation of oxygen concentration to voltage like aluminum electrolysis
- Definition of save process window is possible
- Process control based on voltage / cell resistance
- Application in industrial cells require calibration: voltage change due to oxide feeding
- save up to 340 t CO_2-equiv./t_{Nd}
- CO_2-equiv. safe per year: about 10 Mio. tons

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