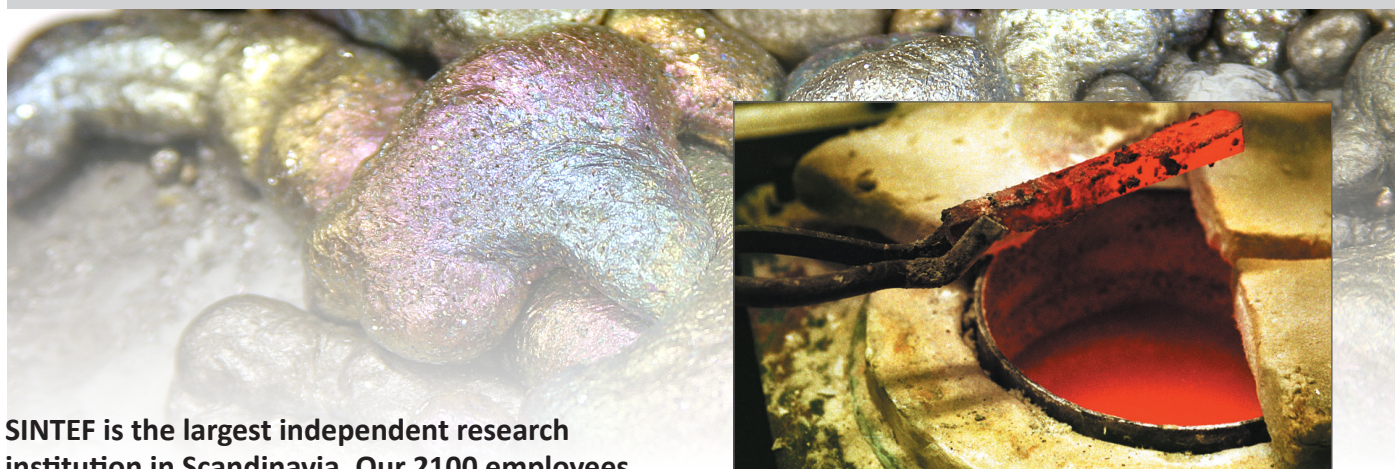


Electrolysis and High Temperature Materials

February 2014



SINTEF is the largest independent research institution in Scandinavia. Our 2100 employees from more than 60 different countries, have international top-level expertise in science and technology medicine and social sciences. The Electrolysis and High Temperature Materials department at SINTEF Materials and Chemistry offers research and development in the field of light metal production.

Aluminium electrolysis is the Electrolysis and High Temperature Materials departments predominant field of work. The scientific collaboration with the Norwegian University of science and Technology (NTNU) in Trondheim makes us one of the largest research groups in the world within light metal production.



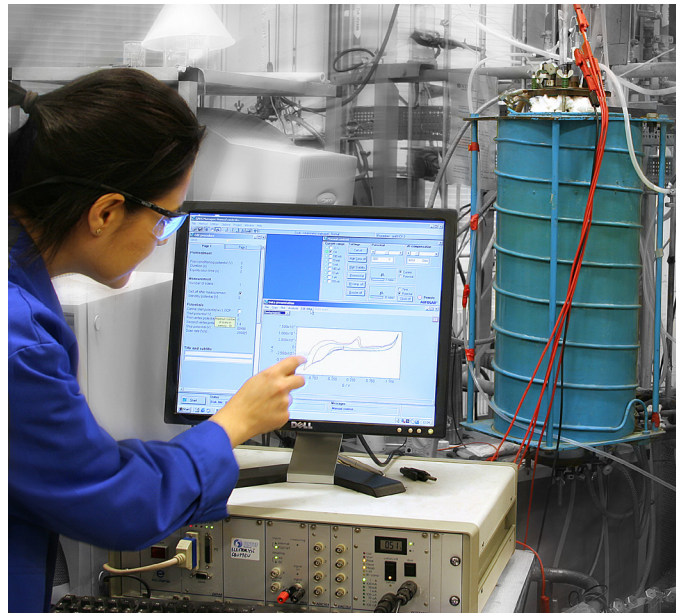
We offer research and development within the following fields:

- **Electrolysis Technology**
 - Aluminium (primary, recycling and refining)
- **New Energy Efficient Electrolysis Processes**
 - Titanium, iron and magnesium
 - Rare earth metals (REM)
 - Silicon (Solar Grade Si)
- **Electrochemical synthesis of nanostructures and thin films from ionic liquids**
- **Recycling and Electrorefining of critical materials**
 - REE contained in WEEE, aluminium, silicon
- **Carbon Technology**
 - Anodes, cathodes, ramming paste, coke and pitch
- **Refractories and Ceramics**
 - Oxides, nitrides, carbides
 - Thermal insulation materials
 - Development and testing
- **Gas Analysis**
 - CO₂/CO (Anode gas)
 - HF, PFC-gases
 - Sulphur gases
- **Autopsies**
 - Identification of failure mechanism

Other topics:

- Alumina properties and characterisation
- Powder preparation
- Environmental technology (CO₂ capture, energy recovery)
- Phase diagram studies
- Thermodynamic (FactSage/HSC)
- Computer modelling of fluid dynamics, gas flow, electrode processes etc. using e.g. COMSOL Multiphysics™ 4.3a

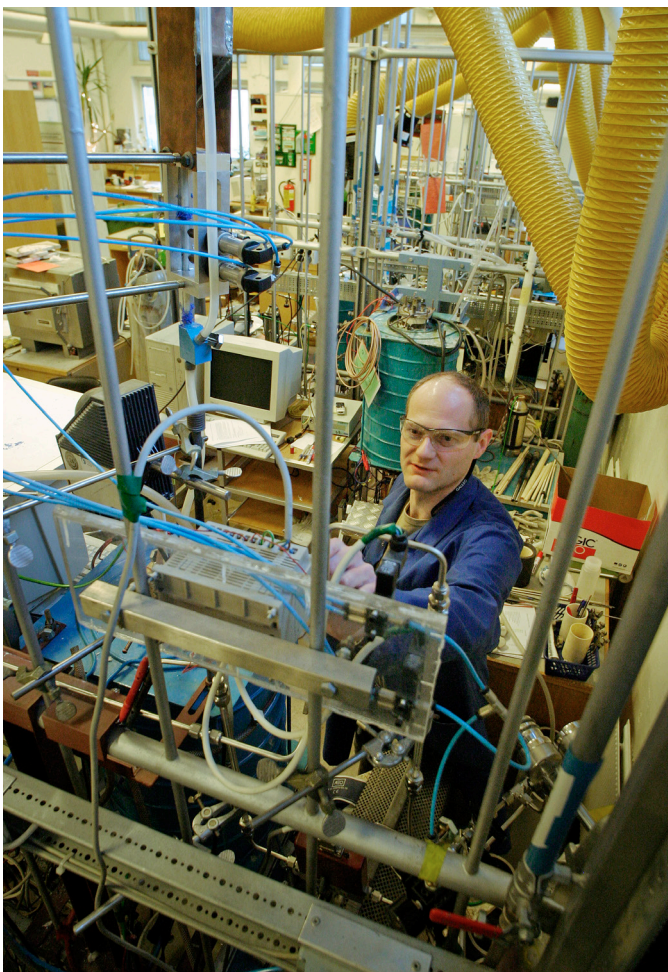
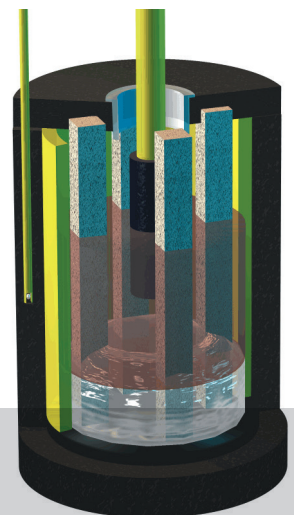
Electrochemical industry has a long tradition in Norway and constitutes one of the country's most important export businesses. Today Norway's aluminium industry in particular holds a strong international position and is Europe's largest manufacturer of primary aluminium.



Selected special tests for aluminium electrolysis cells

- Alumina dissolution rate measurements
- Bottom lining insulation materials: Resistance to cryolite/sodium fluoride melt, aluminium metal and fluoride gases
- Sideline: Quality evaluation of SiC-based materials
- Anodes: Anode consumption by gas-analysis, reactivity to CO₂ and air by thermogravimetric method, baking level (ISO 17499)
- Ramming paste: Preparation of unbaked sample (ISO 14427), Rammability (ISO 17544), Apparent density after compaction (ISO 14427), Loss on baking (ISO 20202), Expansion/shrinkage during baking (ISO 14428)

SINTEF takes part in developing the world's best technology for producing primary aluminium. Our laboratories are well equipped and we are able to perform contract research from laboratory scale to small pilot plant scale.



Laboratory facilities

We cover most areas in the fields of sample preparation, measurements, testing (standardized and customized), characterization, and lab-scale production of materials. Our group closely collaborates with NTNU in R&D by sharing expertise in form of personnel and projects as well as laboratories and instruments.

Analysis (more are available)

- AAS, ICP and IC
- XRD – X-ray diffraction
- LECO for O and N determination
- Laser Flash LFA 457, thermal conductivity up to 1100 °C
- Electron microscopes (e.g. SEM, EMPA, TEM)
- Optical microscopy with image analysis
- GC and GC/MAS – Gas chromatography (mass spectroscopy) and FT-IR
- SINTALYZER Fluoride Analysis

Special equipment

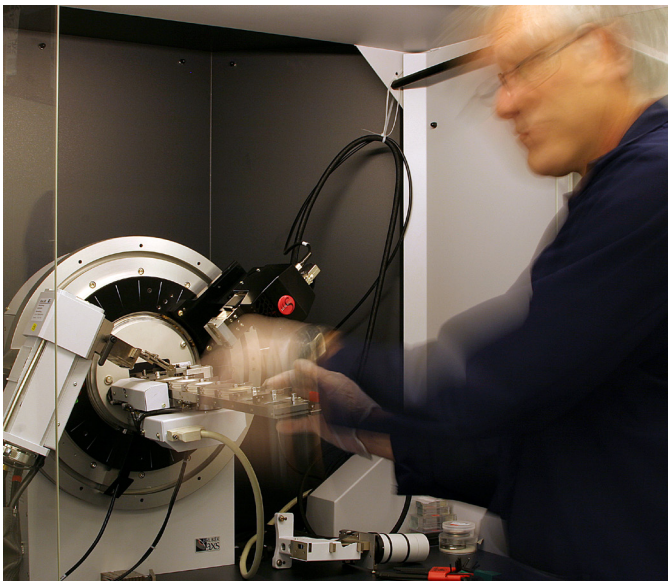
- High temperature furnaces up to 1800 °C, crucible capacity up to 6 kg, power supply up to 3 kA
- Wetting apparatus



- Secotom50, precision cut-off machine for dry-cutting
- Glatt ProCell Labsystem
- Optical dilatometer
- Na gravimetric furnace
- Tomography for 3D-imaging

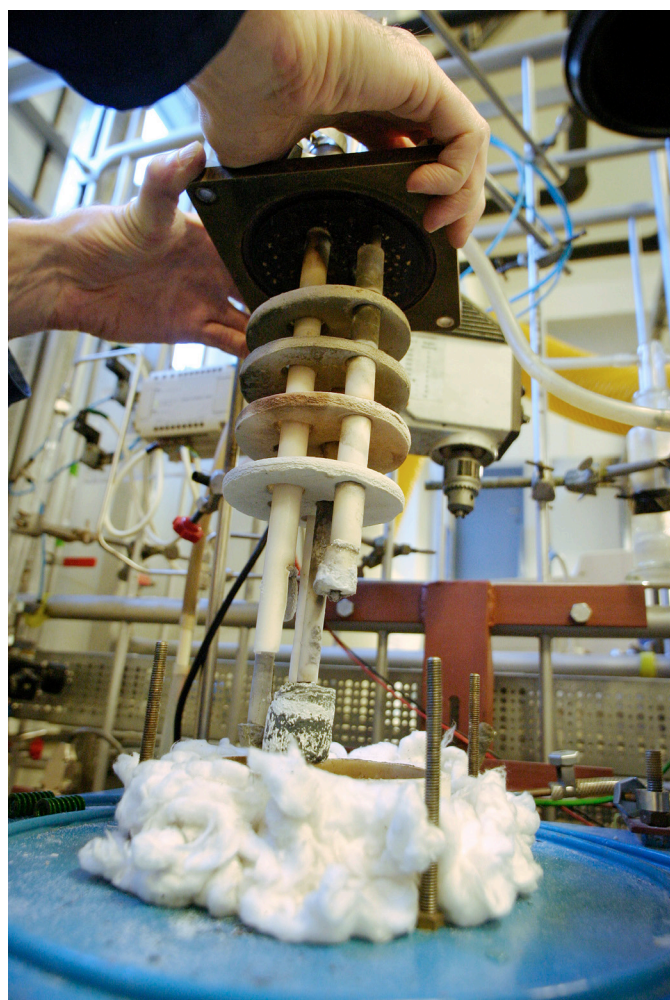
Carbon Test Laboratory (more are available)

- Density and porosity (ISO 12985-1/2, ISO 21687)
- Air permeability (ISO 15906)
- Crushing strength (ISO 18515)
- Bending/shear strength (ISO 12986-1)
- Dynamic Young's modulus (ASTM C1198-91)
- Electrical resistivity (ISO 11713)
- Thermal conductivity by the laser flash method up to 1100 °C
- Coefficient of linear thermal expansion (CTE), from 20-950 °C (ISO 14420)
- Crystallite size, L_c and d_{002} using XRD (ISO 20203)
- Image analysis of carbon materials (porosity and texture)
- Ash content (DIN 51903)



Refractory Test Laboratory (more are available)

- Density and porosity (ISO 5016, ISO 5017)
- Cryolite resistance cup test (ISO 20 292:2009)
- Aluminium resistance cup test (72 h)
- Cold crushing strength (ISO 8895, PRE R/14)
- Modulus of rupture (ISO 5013)
- Permanent change in dimensions on heating (ISO 2477/2478)
- Thermal conductivity by hot wire (ISO 8894-1) and laser flash method
- Reversible thermal expansion (Netzsch dilatometer 402 E)
- Phase- and microstructure analysis



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