PrimaLab

The SINTEF group is one of the largest independent research foundations in Europe. 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 metals production. As part of the research activities, standard test methods have been adopted or new tests have been developed. PrimAlab offers, on a commercial basis, fast and reliable tests in the areas of carbon and refractory materials, electrolyte properties, raw materials and environmental concerns.

- **Cell Materials**
  The refractory and carbon materials used in the construction of an electrolysis cell are evaluated using various test methods. Both side and bottom-lining materials are covered, including testing of well established materials as well as new types of materials. The area of carbon testing covers all types of carbon products and binders used in the electrolysis cells. In combination with the measured data, model tools may also be used to improve the design and the operation of the cells.

- **Refractories**
  The deterioration of side lining materials, which may be accelerated by temporarily melting of the protective side ledge, have to be low to maintain long and stable operation of a cell. A special test method, suitable for evaluation of potential side lining materials against the chemical environments of an aluminium electrolysis cell, has been developed. This chemical resistance test is established in collaboration with the aluminium industry as part of an evaluation program on existing and prospective cell materials. Most often chemical analysis, phase composition and physical properties are included.
  Penetration of electrolytic bath components through the carbon cathode causes mineralogical transformation in the refractory lining, resulting in increased heat loss through the cathode lining and thereby higher energy consumption. An in depth understanding of the influence of refractory material properties on the observed lining deterioration has been gained by a combination of laboratory testing and cell autopsies.

    - **General Tests**

      - Phase- and Microstructure Analysis
      - Thermal Conductivity (Hot-Wire, THS-Method)
      - Gas Permeability
      - Bulk Density and Apparent Porosity
      - Thermal Expansion
      - Modulus of Rupture
      - Cold Compressive Strength

    - **Bottom lining**

        - Resistance to Fluoride Melts (Cup-Test, Crucible-Test)
        - Resistance to Liquid Aluminium (Cup-Test)
        - Resistance to Fluoride Gas (Crucible-Test)
    - **Side lining**
        - Chemical Resistance
        - Oxidation Resistance

- **Carbon**
  The composite nature of the carbon materials used in the aluminium production, combined with a multitude of raw materials and treatment process variables, makes testing very important. A long tradition of experimental work and development of new test methods have resulted in several international standards. Through a close co-operation with the industry, in addition to serving the national and international suppliers to this industry, the usefulness of the methods have been verified.
    - **General Tests**
        - Image Analysis of Carbon Materials
        - Mechanical Strength at High Temperature
        - Thermal and Electrical Conductivity
        - Gas Permeability
        - Pitch and Synthetic Binders for Carbon Materials
        - Lc and Equivalent Temperature
        - Scanning Electron Microscopy with EDX
        - Sodium Vapour Test
        - Expansion/Shrinkage during Baking
    - **Cathodes**
        - Wear of Cathodes in Aluminium Electrolysis
        - Bath Penetration and Reactions in the Cathode
        - Sodium Expansion
    - **Anodes**
        - Lab Scale Anode Production Line
        - CO2- and Air-Reactivity
        - Combustion and Gas Cleaning in Baking Plants

- **Electrolysis**
  A combination of fundamental work in the laboratory and experience from measurements on industrial cells has resulted in a good understanding of fundamental problems as well as the significance of various test methods. Typical problems may be linked to electrode processes where increased understanding is obtained through experimental techniques like voltammetry and impedance measurements. Also the significances of metal and bath flow, bath-metal wave height, alumina distribution, anodic and cathodic overvoltage, and current efficiency (gas analysis), have been studied. We are well equipped to carry out bath property studies, i.e. electrical conductivity, phase diagram studies, thermodynamic data and the kinetics of alumina dissolution. Other activities are analysis of anode effect gases (CF4, C2F6) and sulphurous gases (SO2, COS). Physical modelling of proprietary electrolysis cells has also been done in cooperation with the metal producers. We are also equipped to take part in development and testing of inert electrodes, i.e. ceramic wettable cathodes and oxygen-evolving anodes.

    - **Test methods**

      - Liquidus temperature of cryolitic melts
      - Electrolytic anode carbon consumption
      - Solubility and dissolution behaviour of industrial alumina in Hall-Heroult electrolyte.

- **Chemical Analysis**
  Chemical analysis has for many years been a service to the research groups at SINTEF/NTNU and to the industry. The commercially offered SINTALYZER system for fluorine analysis in all kinds of matrixes is developed in our group. The laboratory is also accredited according to EN-NS 45001 for fluorine, heavy metals and PAH (polycyclic aromatic hydrocarbons) analyses. The instrumentation includes AAS (Atomic Absorption Spectrophotometry); ICP (Inductively Coupled Plasma); IC (Ion Chromatography); XRD (X-Ray Diffraction); LECO for O, N, C, and S; SEM with EDX (Scanning Electron Microscope); GC and GC/MS (Gas Chromatography/Mass Spectroscopy) and Microwave Digestion Equipment.

    - Examples

      - Total Bath Composition (Al2O3, AlF3,CaF2)
      - Impurities in Bath and Metal
      - Refractory Materials (SiC, N, O, Si, Fe, Al, and Ca)
      - SINTALYZER Fluorine Analyses
      - Environmental Samples (PAH, F, Heavy Metals)

- **Research**

  Process industries have a constant need for improving their production processes and to develop new production technologies. SINTEF and NTNU

have been dedicated to increase fundamental knowledge as well as serving the more immediate needs of the light metals producers. Less emission of F, CO2, and PAH, better utilisation of raw materials, materials for extended cell life, and improved energy efficiency are vital in maintaining a competitive production. We have fundamental and practical competence in inorganic chemistry and materials science, electrochemistry, applied thermodynamics, multivariate analysis, and mathematical modelling of production processes.

Our laboratories are well equipped and we are able to perform contract research from laboratory scale to small pilot plant scale.

Some of the staff engaged in the light metal and materials research as well as the test facilities served by the PrimAlab.