EQUIPMENT & FACILITIES

CSIR - National Metallurgical Laboratory

(Under DSIR, Ministry of Science & Technology, Govt. of India)

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OVERVIEW of CSIR-NML

The foundation stone for the National Metallurgical Laboratory was laid by the Hon'ble Sri C. Rajagopalachari on 21st November, 1946. The laboratory was formally inaugurated and dedicated to the nation on 26th November, 1950 by Pandit Jawaharlal Nehru *"in a spirit of hope and faith in the future".* NML was born out of the visionary efforts of Sir Shanti Swaroop Bhatnagar, who envisioned a network of research institutions across India to drive progress in science and technology.

Since its inception, CSIR-NML has played a significant role in India's industrial revolution, especially in mineral processing, iron and steel making, ferroalloys, and non-ferrous metal extraction, notably magnesium. In the early 1970s, the laboratory established Asia's largest creep testing facility, which today continues to be the second largest in the continent. CSIR-NML continues to play a vital role in the quest of the country towards scientific and technological leadership and providing scientific solutions to the industries in the areas of minerals, metals, and materials.

Over the decades, CSIR-NML has evolved into a multidisciplinary research institution, with expertise spanning mineral beneficiation, extractive metallurgy, indigenous alloy development, corrosion studies, refractories, physical and mathematical modeling of metallurgical processes, advanced materials, structural integrity assessment, and sustainable metallurgical practices.

Beyond industrial research, CSIR-NML is also engaged in outreach activities aimed at raising public awareness on health, environmental sustainability, rural technologies, and development issues.

Backed by a team of highly skilled and dedicated professionals, along with state-of-the-art facilities, CSIR-NML remains steadfast in its mission to address global challenges and support India's journey toward scientific and technological excellence.

Vision

To be a nationally relevant, globally benchmarked and self-sustained technology & innovation center in Minerals, Metals and Materials Engineering.

Mission

To develop technologies that meet the need of the country, provide sustainable solutions to Industry and add value to our society through dissemination of knowledge, skill building and developing entrepreneurship

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FOREWORD

Equipment facilities, manpower and organizational processes are important knowledge assets which build a strong foundation for a R&D organization. One can draw a similarity by stating that manpower and organizational processes are the software and firmware, whereas equipment facility is the hardware for a research organization.

This brochure showcases the cutting-edge research & testing facilities available at CSIR National Metallurgical Laboratory (NML). The facilities presented in this brochure support precise scientific experimentation, mineral and material processing, comprehensive characterization, and evaluation across a wide range of applications. They also contribute to the advancement of materials technology.

Professionals and researchers in the minerals, materials, and metallurgical sectors are encouraged to explore and utilize the capabilities presented in this brochure to further their work through CSIR-NML's resources.

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Contents

Contents

Contents

Contents

Analytical and Applied Chemistry

AAC

CSIR-NML Jamshedpur

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Ash Fusion Temperature Determinator

Research Area: Chemical/Coal Analysis

Ash fusion temperatures are a critical quality control parameter in predicting the performance of coal, evaluating the tendency of coal to slag, and controlling the melting temperature and behavior of mold powder in steel-casting production.

The AF700 Ash Fusion Determinator automatically monitors ash cone deformation temperatures. It determines the ash fusibility temperatures (IT, ST, HT, and FT) using the software's Image Recognition Functions (IRF).

A complete image history for all analyzed samples can be digitally archived and retrieved to make objective determinations and confirmations of deformation temperatures.

Equipment Information

- Model & Make: AF 700, Leco, USA
- Year of Installation: 2013
- Application: Coal analysis
- Sample: Ash (1 gm in powder form)

Low-Temperature Gray-King (LTGK)

Research Area: Chemical/Coal Analysis

The Low-Temperature Gray-King (LTGK) analysis of coal is a crucial test used to evaluate its coking and carbonization properties. This analysis helps determine how coal behaves when subjected to low-temperature carbonization, typically around 600°C, and is widely used to assess its suitability for coke production. The process involves heating a carefully prepared coal sample in a silica retort under controlled conditions, during which volatile matter is driven off, leaving behind a solid coke residue. The test measures several key parameters, including the percentage of coke residue, the degree of swelling or contraction, porosity, and texture

Equipment Information

- Year of Installation: 2016
- Application: Coal analysis
- Sample: Coal Powder

Crucible Swelling Index

Research Area: Chemical/Coal Analysis

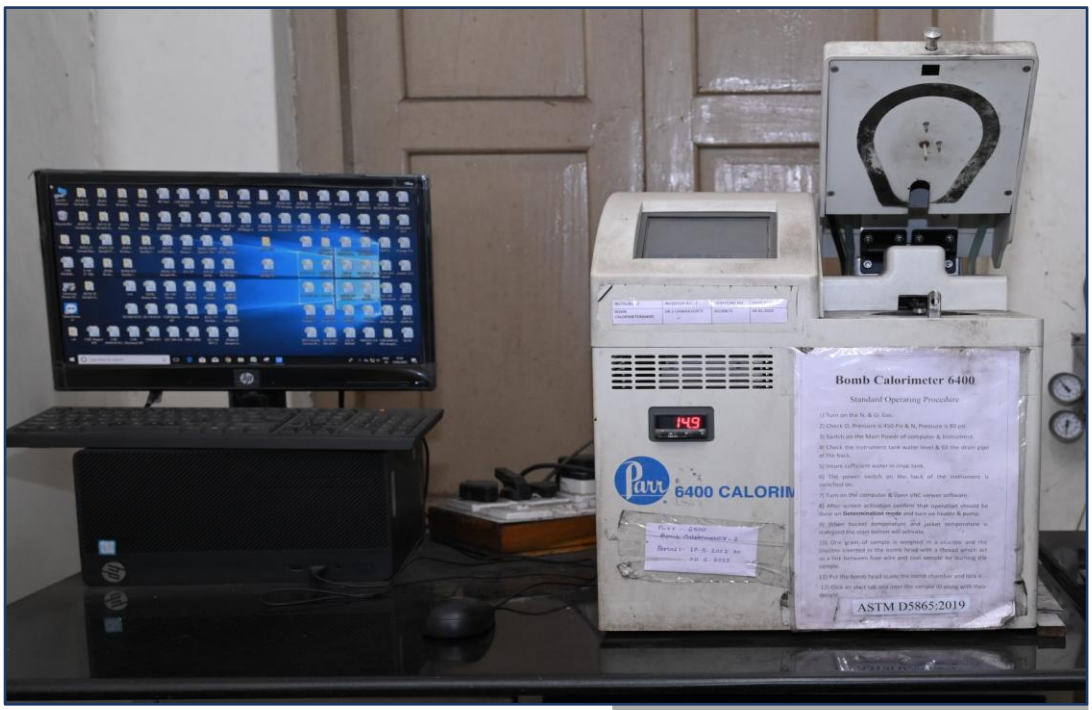
The Crucible Swelling Index (CSI) is a key test used to evaluate the swelling properties of coal when heated, providing crucial insight into its coking potential. This test involves heating a finely ground 1-gram coal sample in a silica crucible at approximately 820°C, during which the coal decomposes, releasing volatile matter and forming a plastic mass that later solidifies into a coke button. The degree of swelling is then compared to a standard reference scale ranging from 0 to 9, where 0 indicates no swelling and 9 represents extreme expansion. Coals with low CSI values (0–1) are classified as non-coking, those with moderate values (2–4) are suitable for blending in metallurgical coke production, while high CSI coals (5–9) are ideal for producing strong metallurgical coke.

Equipment Information

- Year of Installation: 2016
- Application: Coal analysis
- Sample: Coal powder

Bomb Calorimeter

Research Area: Chemical/Coal Analysis



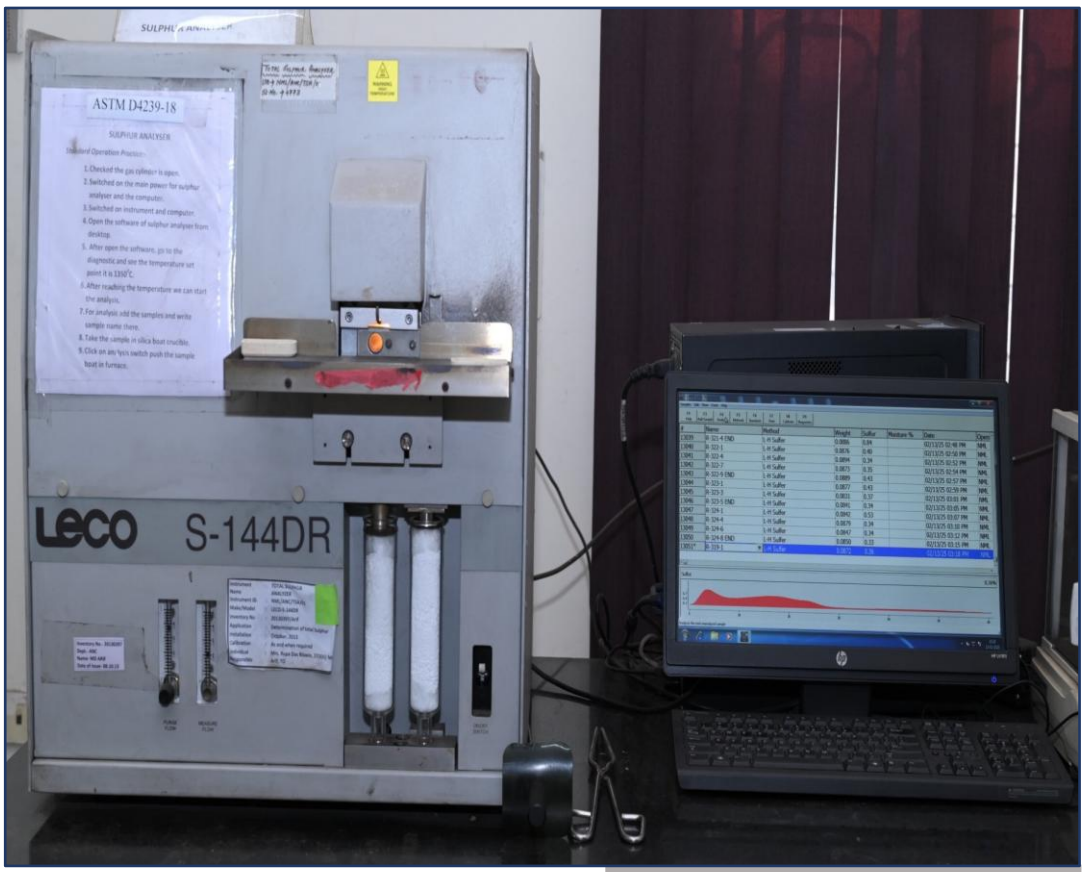
A bomb calorimeter is used to determine the calorific value of fuels. A known amount of the fuels (coal, petroleum products) is burnt inside a stainless-steel bomb in a water bucket containing a known volume of water in excess oxygen. The heat produced by the combustion raises the temperature of the water, which is used to calculate the calorific value of the fuel.

Equipment Information

- Model & Make: 6400, Parr, USA
- Year of Installation: 2019
- Application: Coal analysis
- Resolution and Range: 100-10000 Cal/g
- Sample: Solids (1 gm in powder form)

Sulphur Analyzer for Coal

Research Area: Chemical/Coal Analysis



Sulfur analyzer is used to determine total sulfur content in coal. Coal is burnt in presence of excess oxygen and the SO, gas produced is analyzed using IR detector. The analysis is fast with each sample taking 3 min approximately.

Equipment Information

- Model & Make: S-144DR Dual Leco, USA
- Year of Installation: 2013
- Application: Coal analysis
- Sample: Solids (1 gm in powder form)

Proximate Analyzer for Coal

Research Area: Chemical/Coal Analysis

Proximate analyzer is used for proximate analysis of coal. The instrument determines the moisture, Ash, Volatile Matter, and loss on ignition content of coal by measuring the weight loss at different temperatures in controlled environment. 19 samples can be analyzed simultaneously in selectable Nitrogen, Oxygen or Air atmosphere.

Equipment Information

- Model & Make: TGA701 Dual Leco ,USA
- Year of Installation: 2019
- Application: Coal analysis
- Sample: Solids (1 gm in powder form)

CRI-CSR Analyzer for Coal

Research Area: Chemical/Coal Analysis

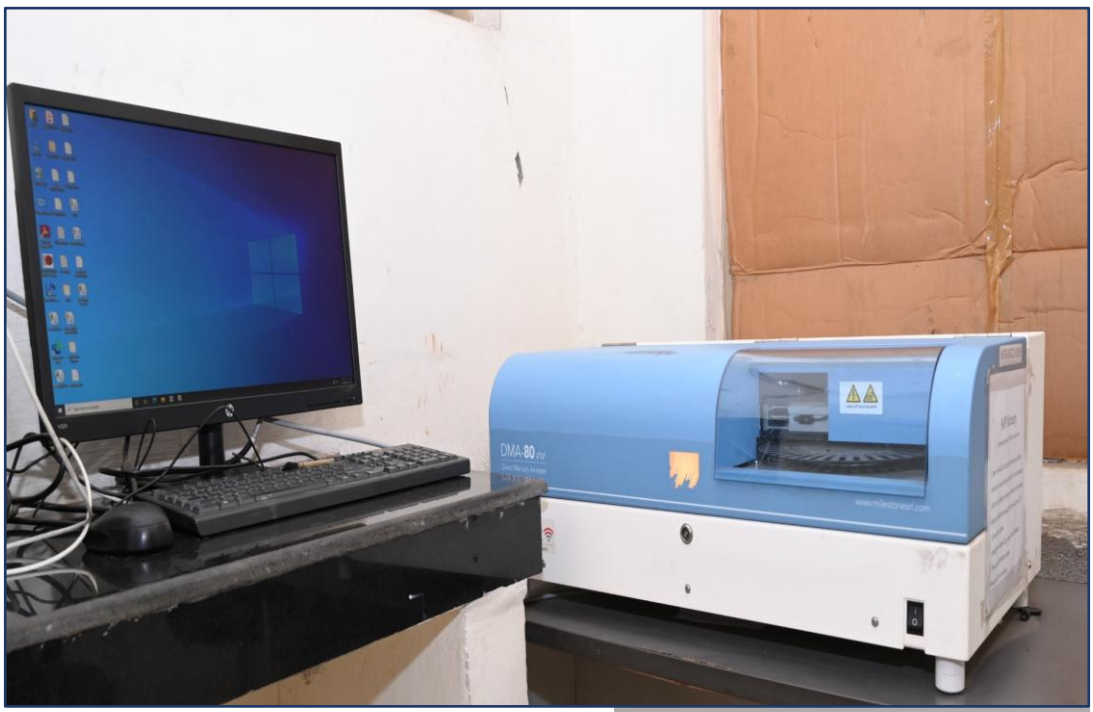
The equipment measures (i) Coke Reactivity Index (CRI) and (ii) Coke Strength after Reaction (CSR), indicative of the performance of coke in the Blast furnace. 200 g of sample is heated with CO_2 at 1100°C in a retort, followed by tumbling. The percentage of mass loss gives CRI, and the percentage of + 10 mm particles retained by tumbling gives CSR as per ASTM protocol. The data is useful in determining coal quality for blast furnace applications.

Equipment Information

- Model & Make: SIPL-CSR-HM120 CSR/CRS equipment, Salvin, India
- Year of Installation: 2021
- Application: Coal analysis
- Sample: Solid

Mercury Analyzer for Coal

Research Area: Chemical/Coal Analysis



The Direct Mercury Analyzer (DMA) is an advanced instrument designed for the precise measurement of mercury (Hg) in solid, liquid, and gaseous samples without the need for complex chemical preparation. This technique is based on thermal decomposition, gold amalgamation, and atomic absorption spectrometry (AAS). The sample is first heated in an oxygen-rich environment, releasing mercury vapor. The vapor is then captured by a gold amalgamation trap, which concentrates the mercury before it is thermally desorbed and analyzed using atomic absorption spectroscopy

Equipment Information

- Model & Make: DMA-80 evo Milestone, USA
- Year of Installation: 2022
- Application: Hg analysis in geological and environmental samples
- Sample: Solid & Liquid

C H N Analyzer for Coal

Research Area: Coal Analysis

CHN analyzer is used for the 'Ultimate analysis' of coal. The instrument works according to the principle of catalytic tube combustion in an oxygenated atmosphere and high temperatures. The combustion gases are freed from foreign gases (for instance, volatile halogen). The desired measuring components are separated from each other with the help of specific adsorption columns and determined in succession with a thermal conductivity detector (TCD). Helium (He) serves as a flushing and carrier gas. Some useful applications include the 'Ultimate analysis' of coal, determining the elemental composition of organic compounds to determine molecular formulas, etc.

Equipment Information

- Model & Make: CHN 628, Leco, USA
- Year of Installation: 2016
- Application: Coal analysis
- Sample: Ash (1 gm in powder form)

Inductively Couple Plasma Optical Emission Spectrometer (ICP-OES)

Research Area: Chemical Analysis

The iCAP7600 series of ICP OES is a powerful dual-view spectrometer, which is used for the analysis of trace, minor & major elements present in aqueous samples like Water, wastewater, leachate, etc. Analysis of Mineral, Ores, Metals, Steel, and other Alloy samples can also be done after their digestion in suitable acid reagents.

Equipment Information

- Model & Make: iCAP7600/ Thermo Fisher Scientific Ltd.
- Year of Installation: 2015
- Application: Elemental parameters in aqueous sample
- Resolution and Range: 0.01 to 20 mg/L
- Sample: Solid and Liquid

Atomic Absorption Spectroscopy (AAS)

Research Area: Chemical Analysis

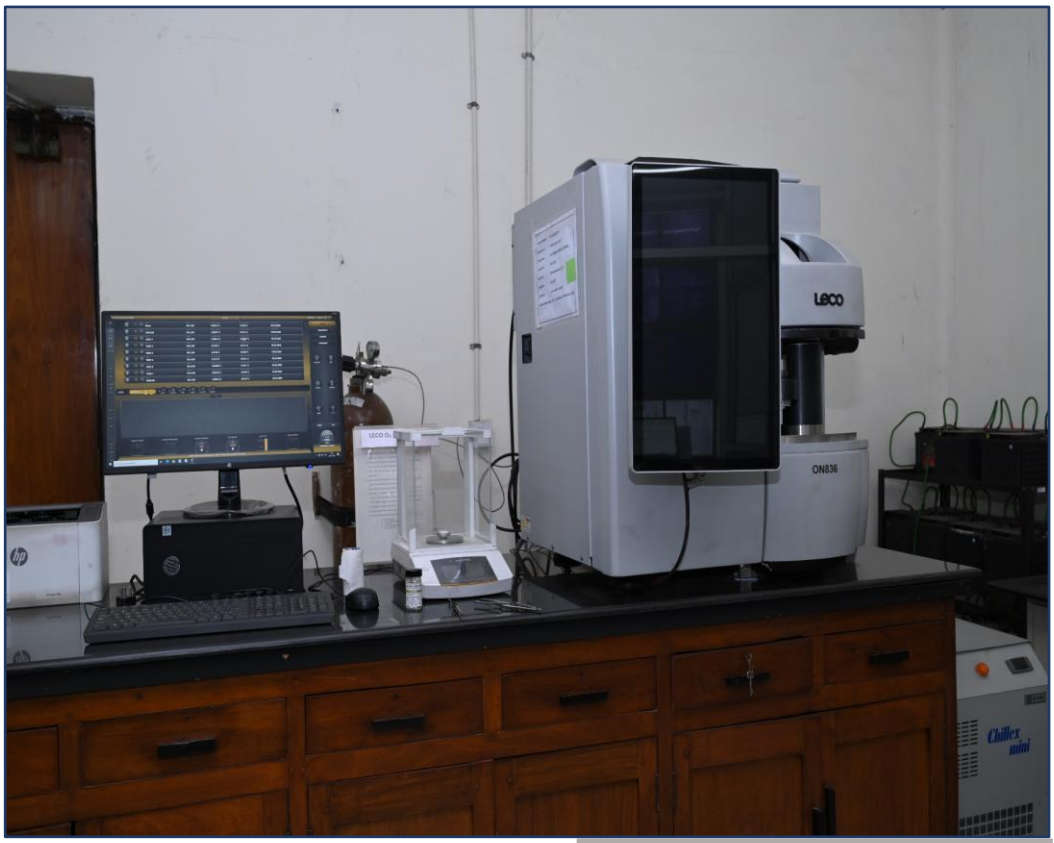
Atomic Absorption Spectroscopy (AAS) detects elements in either liquid or solid samples through the application of characteristics wavelength of electromagnetic radiation from the light source. Individual elements will absorb wavelengths differently and this absorbance are measured against standards.

Equipment Information

- Model & Make: iCE 3000 Series / Thermo Fisher
- Year of Installation: 2010
- Application: Detection and measurement of the concentration of elemental parameters in solution
- Resolution and Range: 0.01 ppm to 1%
- Sample: Solids and Liquids

O_2/N_2 Analyzer in Metals

Research Area: Analytical Chemistry



Elemental Analyzer is designed for wide-range measurement of oxygen, nitrogen content in steel and other metal. ferrous and nonferrous alloys using the inert gas fusion technique. This instrument has Automation and Cornerstone brand touch-screen software together to streamline the analysis, while a robust design ensures reliability.

Equipment Information

- Model & Make: LECO ON 836 & Model No.-632-200-400
- Year of Installation: 2021
- Application: Measurement of Oxygen & Nitrogen content of Inorganic materials
- Resolution and Range: O = 0.5 ppm - 5% & N = 0.5 ppm - 3%
- Sample: Pin/turning

Inductively Coupled Plasma Mass Spectrometer (ICP-MS)

Research Area: Chemical analysis

ICP-MS is a top-tier elemental analysis instrument offering sensitivity and efficiency. The ICP/MS 7800 features advanced hardware and delivers high performance, but its unique advantage is workflow simplification, including simple sample preparation, method setup, and routine operation. Sets new standards in elemental analysis, which simplifies method development and routine operation. In helium collision mode, polyatomic interference is reversed, enabling the analysis of elements from parts per billion to high parts per million in a single run. HMI or high matric introduction technology lets your analysis sample containing up to technology lets you analyze samples containing up to 3 % TDS without dilution, reducing sample preparation and saving time.

ICP/MS Features:

- Ultra-Sensitive Detection
- Fast Data Acquisition
- Robust Design
- Intuitive Software
- Comprehensive Analytical Capabilities
- Low Matrix Interference
- Mass Range Flexibility
- Collision/Reaction Cell Technology

Equipment Information

- Model & Make: [ICP-MS], Agilent 7800
- Year of Installation: 2020
- Application: Environmental monitoring, food safety, pharmaceutical analysis, geological studies, and materials sciences etc.
- Resolution and Range: 0.1 µg/L to 0.1%
- Sample: Solid and Liquid

Direct Reading Spectrometer (DRS)

Research Area: Analytical Chemistry

Equipment Information

- Model & Make: Q8 Magellan Bruker GmbH
- Year of Installation: 2009
- Application: Elemental analysis of all types of metals
- Resolution and Range: 10 mg/Kg - 99.90 %
- Sample: Disc shape

This equipment determines the concentration of elements present as alloying elements or as impurities in steel. CSIR-NML has four base calibration Spark spectrometers for Fe, Ni, Al, and Mg. It works by exciting atoms in a sample with an electric arc or spark, causing them to emit light at specific wavelengths, which are then analyzed to determine the sample's elemental composition.

H_2 Analyzer in Metals

Research Area: Analytical Chemistry

Hydrogen Determination by Inert Gas Fusion Thermal Conductivity Detection
Determine hydrogen content for Steel, aluminum & other metals sample with the RHEN602. It has furnace operating parameters that optimize sample size, accuracy, and precision. The RHEN602 handles a wide range of metals, especially at low levels (< 2 ppm). Multiple method selection are available that assures optimal furnace and analysis settings for each sample matrix. The RHEN602 provides an advanced electrode furnace operating system for more detailed temperature profiles and complete control of set points and ramp rates.

Equipment Information

- Model & Make: LECO RHEN602 & 631-100-500
- Year of Installation: 2021
- Application: Determination of hydrogen content in Steel, aluminum & other metals
- Resolution and Range: 0.1 ppm to 0.25 %
- Sample: Pin shape

Ion Chromatography

Research Area: Analytical Chemistry

Equipment Information

- Model & Make: Metrohm 882
- Year of Installation: 2013
- Application: Analysis of anions and cations in water sample
- Resolution and Range: 2 µg/L to 100 mg/L
- Sample: Solid and Water

Ion chromatography is used for water analysis. The instrument is able to measure concentrations of major anions, such as fluoride, chloride, nitrate, nitrite, and sulfate, as well as major cations such as lithium, sodium, ammonium, potassium, calcium, and magnesium in the ppb to ppm range. Ion chromatography measures concentrations of ionic species by separating them based on their interaction with a resin. Ionic species separate differently depending on species type and size. Sample solutions pass through a pressurized chromatographic column where ions are absorbed by column constituents. As an ion extraction liquid, known as eluent, runs through the column, the absorbed ions begin separating from the column. The retention time of different species determines the ionic concentrations in the sample.

CS Analyzer

Research Area: Analytical Chemistry

The elemental analyzer ELEMENTRAC CS-i measures the Carbon and Sulfur concentration in predominantly inorganic samples through combustion in an induction furnace and the subsequent analysis of the gaseous combustion products carbon dioxide and sulfur dioxide. The high temperature of more than 2000°C ensures complete decomposition of the sample and thus reliable and accurate elemental analysis over a wide concentration range.

Equipment Information

- Model & Make: ELTRA CSi
- Year of Installation: 2024
- Application: Measurement of Carbon & Sulfur in metals, ores, and other inorganic materials
- Resolution and Range: C = 0.01-7 %, S = 0.001-1 %
- Sample: Pin/Turning/Powder

Wavelength Dispersive X-ray Fluorescence Spectrometer (WD-XRF)

Research Area: Analytical Chemistry

Bruker S8 Tiger is a Fully Automated Sequential WD-XRF for high speed and high precision Qualitative and Quantitative analysis of elements ranging from Beryllium to Uranium, which is used for the analysis of minor & major elements in geological, environmental, metal and alloy samples.

Equipment Information

- Model & Make: S8 TIGER & Bruker Instruments
- Year of Installation: 2012
- Application: Analysis of elemental parameters
- Resolution and Range: mg/Kg to % range
- Sample: Solid Powder

UV-Vis Spectroscopy

Research Area: Analytical Chemistry

UV-Vis spectroscopy is an analytical technique that measures the amount of discrete wavelengths of UV or visible light that are absorbed by or transmitted through a sample in comparison to a reference or blank sample. This property is influenced by the sample composition, potentially providing information on what is in the sample and at what concentration. The instrument works on the principle of Beer-Lambert law.

Equipment Information

- Model & Make: Labtronics, LT-28
- Year of Installation: 2024
- Application: Characterization of bioactive compounds, functional groups, speciation analysis of elements etc.
- Resolution and Range: 1 µg/L to 1 mg/L
- Sample: Aqueous

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Advanced Materials and Corrosion

AMC

CSIR-NML Jamshedpur

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Arc Melting Furnace with Suction Casting

Research Area: Alloy Development

Equipment Information

- Model & Make: Arc Melting & Hind High Vacuum, India.
- Year of Installation: 2010
- Application: Alloy making, casting
- Resolution and Range: High (~ 99 %) purity alloy & inert (argon) atmosphere; Max. 200 g ferrous alloy
- Sample: High purity (~ 99 %) raw materials

Synthesized special grade of alloys (Fe, Ni, Ti, Cu etc.) under inert atmosphere.

Processing rods (~ 1-10 mm diameter & length 100 mm) and sheets (~ 0.5-2 mm thickness, 10 mm width & length 100 mm).

Single-step processing method with the consequence of melting of materials and its suction casting inside a copper mould.

Vacuum Melt Spinning Unit

Research Area: Advanced Materials Processing

The melt spinning unit involves a rapid solidification processing route through the melt spinning technique for the preparation of the ribbons directly from the melt. In this technique, the molten metal is induction melted and ejected into a rotating copper wheel. The process can be carried out in air or an inert atmosphere. The instrument has the capability of melting 1 kg of Fe-based alloy. The process parameters include nozzle slit geometry, separation of nozzle slit and copper wheel, wheel speed, ejection melt temperature and pressure.

Equipment Information

- Model & Make: Designed by NML: Fabricated at Vacuum Techniques, Bangalore
- Year of Installation: 2006
- Applications: Production of amorphous and nanostructured ribbons directly from the melt of ferrous and non-ferrous alloys.
- Input material: Alloy ingots typically for ferrous alloys with a diameter of 20 to 25 mm, height ~ 100 mm, and weight up to 1 kg of Fe-based alloy
- Output material: Ribbons of up to 25 mm width and 30-50 microns thickness.

Vacuum Oven

Research Area: Material Heat Treatment

Low temperature heating of any metallic material for the purpose of de-moisturizing & structural relaxation.

Equipment Information

- Model & Make: RLE-VORE-STD-27L & Ants Prosys, India
- Installation: 2024
- Application: Low temperature heat treatment & drying
- Resolution and Range: 1 bar pressure vacuum & Max heating temperature of 250±1°C
- Sample: Metallic material (non-inflammable & non-volatile)

Hot Dip Process Simulator (HDPS)

Research Area: Hot Dip Coating, Heat Treatment

The state-of-the-art national facility, HDPS, can provide a comprehensive solution to industrial issues. It performs a realistic simulation of thermal treatment, galvanizing, galvannealing, and aluminizing processes for Advanced High Strength Steels (AHSS). The optimized process parameters can be directly transferred to the plant for trial.

Equipment Information

- Model & Make: HDPS V1.4 & Iwatani Surtec
- Year of Installation: 2016
- Application: GI & GA coatings, Al-Si-X & ZAM coatings
- Resolution and Range:
  Annealing temp: up to 1100°C,
  DP: +70 to -60°C,
  Bath temp: up to 800°C
- Sample: 130 x 220 x (0.3 to 3) mm & smaller size

RF/DC Magnetron Sputtering System

Research Area: Coating

The magnetron sputtering can be used for coating single layer and multilayers of metals, alloys, ceramics, and some high-temperature polymers such as Teflon, etc. It is an atomic deposition PVD process, done by plasma generation. The unit has the capability of $1x10^{-6}$ mbar. It has 3 magnetron sources with a substrate holder having substrate heating and biasing facilities up to 700°C and 200 V, respectively.

Equipment Information

- Model & Make: HHV, Multitarget RF/DC sputtering unit, SN 2178
- Year of installation: 2008
- Application: Coatings single layer and multilayer of metals, alloys, ceramics, and composites
- Resolution & Range: Temperature: 700°C, Biasing voltage: 200 V, Pressure: $1x10^{-6}$ mbar
- Sample: Flat 1 mm - 80 mm (square, rectangular, or circular)

Pulsed Plasma Ion Nitriding

Research Area: Surface Engineering

Plasma ion nitriding (PPIN) is used to modify the surface of steel components through a controlled nitrogen diffusion process to achieve high hardness, corrosion, fatigue, and wear resistance. PPIN is a modern and environmentally clean method of incorporating nitrogen in steel components. This makes it possible to nitride the steel surfaces even without the formation of a brittle white layer, thus reducing the finishing cost of the component. By controlling the pulse duration and repetition time, arc discharge can be effectively suppressed, treatment temperature can be varied without altering plasma parameters, and the phase constitution of the layer can be altered. Very complex shapes can be treated successfully, and the active species can also enter blind holes, producing completely uniform modified layers on all parts in a heavily loaded chamber

Equipment Information

- Model & Make: Plasmon 600, Milman, Pune
- Year of Installation: 2009
- Applications: Surface modification of steel components
- Resolution & Range: Nitriding temperature up to 600°C, Frequency: Variable from 1 to 30 kHz, Voltage: 600 V, Duty Cycle: Variable
- Sample: Metal components, sheets, etc.

Electron Beam Evaporation Unit

Research Area: Coating

Electron beam evaporation is used for coating single layer and multilayers of metals, alloys, and ceramics. It is an atomic deposition PVD process, done by Thermal evaporation, where the coating material is melted with the help of an electron beam gun. The unit has the capability of $1x10^{-7}$ mbar. It has 2 electron guns having 4 crucibles in each. The substrate (on which coating is required) also has a heating facility up to 700°C.

Equipment Information

- Model & Make: HHV, Electron Beam evaporation unit, SN 2237
- Year of Installation: 2009
- Application: For making thin-film as well as thick-film multilayers
- Sample: Flat 5 mm – 150 mm (square, rectangular, or circular)

Cyclic Corrosion Test (CCT)

Research Area: Corrosion and Coating

To perform corrosion studies on metals/alloys/nonmetallic materials by means of recreating/accelerating a variety of corrosive climates within the convenience of an enclosed test facility.
Facilitates to create 4 distinct climates as follows:
1) Salt spray
2) Condensation humidity (wetting)
3) Air drying
4) Controlled humidity

Equipment Information

- Model & Make: CC450ip & M/s Ascott Analytical Equipment Limited, Great Britain
- Year of Installation: 2017
- Application: Corrosion test in different environments
- Resolution and Range: Salt spray, humidity, and air drying
- Sample: Solid

Closed Loop Corrosion Test RIG Facility

Research Area: Corrosion Characterization

It can be used to simulate the fluid flow and to study the corrosion rate of metals/alloys in the presence of controlled oxygen dissolved in the fluid. The corrosion test rig can be operated/controlled through computer using dedicated software and test data is recorded at set intervals.

Equipment Information

- Model & Make: CSIR NML
- Year of Installation: 2017
- Application: to study the flow-accelerated corrosion
- Sample: Solid

Salt Spray Test Chamber

Research Area: Surface Engineering

The salt spray test is a standardized test method used to check the corrosion resistance of coated samples. Coatings provide corrosion resistance to metallic parts made of steel, zamak, or brass. Since coatings can provide a high corrosion resistance through the intended life of the part in use, it is necessary to check corrosion resistance by other means. Salt spray test is an accelerated corrosion test that produces a corrosive attack on the coated samples in order to predict their suitability for use as a protective finish. The appearance of corrosion products (oxides) is evaluated after a period of time. Test duration depends on the corrosion resistance of the coating; the more corrosion-resistant the coating is, the longer the period in testing without showing signs of corrosion.

Equipment Information

- Model & Make : Model S450 Xp, M/s. Unitron Instrumentation Technology Pvt. Ltd., Bangalore
- Year of Installation: 2010
- Applications: To assess the performance/durability of the particular coatings/paints in exposure to a corrosive environment
- Sample: Painted/coated /uncoated samples

QUV Accelerated Weathering Tester

Research Area: Surface Engineering

QUV Accelerated Weathering testing is a laboratory simulation of the damaging forces of weather for the purposes of predicting the relative durability of materials exposed to outdoor environments. Racks of samples are placed in the QUV chamber. Rain and dew systems are simulated by pressurized spray and condensation systems, while the damaging effects of sunlight are simulated by fluorescent UV lamps. The exposure temperature is automatically controlled.
Cyclical weather conditions can also be simulated.

Equipment Information

- Model & Make: QUV /Spray, Q-Lab Corporation, Cleveland (USA),
- Year of Installation: 2010
- Applications: To study the types of damage, including colour change, gloss loss, chalking, cracking, crazing, hazing, blistering, embitterment, strength loss, and oxidation by sunlight and dew
- Sample: Painted/coated samples

Muffle Furnace

Research Area: High-Temperature Corrosion

To perform high temperature corrosion studies on metals/alloys by means of creating a variety of reactive atmospheres such as (i) Oxidizing (ii) Flue gas within the convenience of an enclosed test facility with controlled flow rate.

Equipment Information

- Model & Make: CWF 12/23 + Nanodac PR controller + Removable Inconnel Retort & M/s Carbolite Gero, UK
- Year of Installation: 2016
- Application: Material evaluation
- Resolution and Range: Up to 1200°C
- Sample: Solid

Thermo-gravimetric Analyzer + QMS (TGA)

Research Area: High Temperature Oxidation & Corrosion Characterization

Thermo-Gravimetric Analyzer and Quadruple Mass Spectrometer will be used in studying and characterizing the thermal properties such as mass change, thermal decomposition, evolved gas analysis for a wide variety of samples from minerals to synthesized metal/metal oxide/ polymeric/Organic and inorganic compounds.

Equipment Information

- Model & Make: Netzsch STA 449 F5 Jupiter + QMS 403D&Netzsch, Germany
- Year of Installation: 2018
- Application: Life expectancy & thermal stability of Material
- Resolution and Range: RT to 1600^{o}C (heating rate- 0.001 to 50^{o}C/min)
- Sample: Solid

High-Temperature Electrochemical Cell

Research Area: Hot Corrosion

Can be used to examine the corrosion behaviour of the various metal/alloys and coatings in high temperature corrosive environment (especially in molten salt atmosphere).

Equipment Information

- Model & Make: S.J. Engineers
- Year of Installation: 2023
- Application: Hot corrosion
- Sample: Metals/Alloys/Coatings

High Resolution Confocal Raman Microscope

Research Area: Materials Characterization

Equipment is equipped with 532 nm and 633 nm lasers. It can directly analyze the flat metallic surface, thin film, and powder samples without sample preparation. It can be used to monitor the in-situ corrosion product on the metallic surface after exposure to a certain environment. Raman spectra can be recorded at different locations by selecting the specific particles/ area through a confocal microscope, which can help to monitor different molecular structure formation and growth.

Equipment Information

- Model & Make: Alpha 300 & WITEC
- Year of Installation: 2019
- Application: Characterization of nanomaterials and composites
- Resolution and Range: Laser wavelength (532 nm & 633 nm)
- Sample: Solid

3D Optical Surface Metrology

Research Area: Material Characterization

Combines confocal metrology in HD with interferometry to a versatile dual-core system. High-performance software, simple module selection with one click, and confocal scanning without movable parts with vertical resolution up to 2nm for surfaces with sloping areas and intricate structures. Interferometry with a resolution up to 0.1 mm for even surfaces with microstructures.

Equipment Information

- Model & Make: DCM8 & M/s Leica, UK
- Year of Installation: 2019
- Application: 3D surface metrology measurement
- Resolution and Range: Up to 2 nm for intricate structures and 0.1 mm for microstructures.
- Sample: Solid

Electron Spectroscopy for Chemical Analysis (ESCA)

Research Area: Materials Characterization

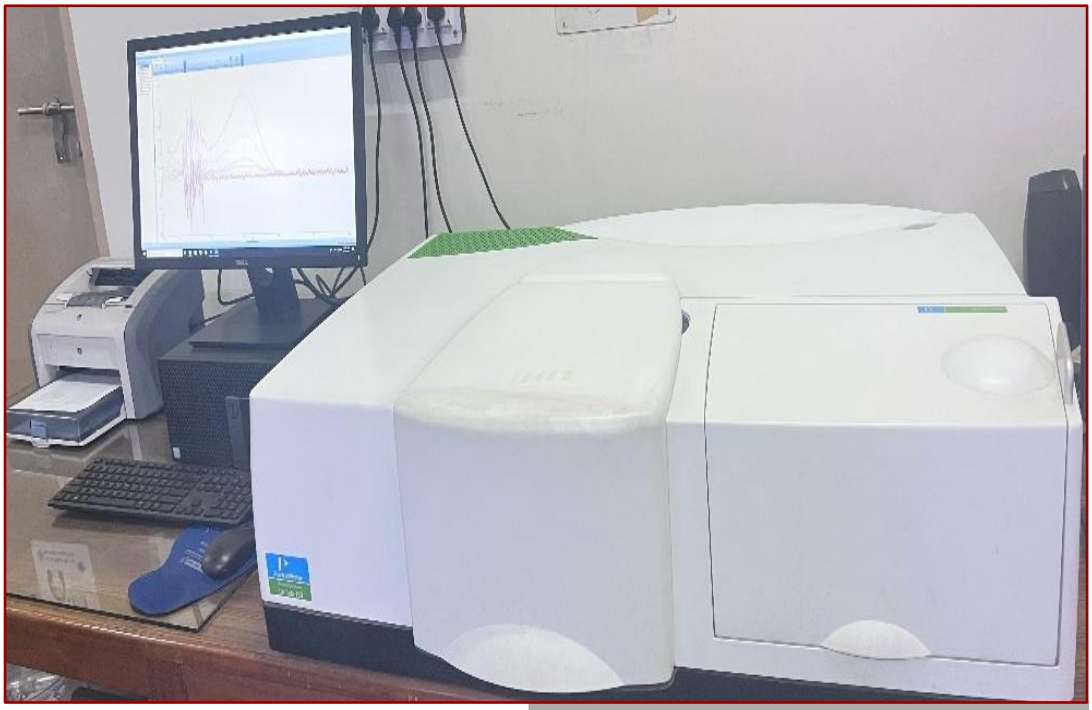
Electron Spectroscopy for Chemical Analysis (ESCA) or X-ray Photoelectron Spectroscopy (XPS) is used to identify the chemical composition of compounds on the surface of a sample. It utilizes X Rays (XPS), Ultraviolet light (UPS), or Auger electrons (AES) to knock off photoelectrons from atoms of the sample. The energy content of these ejected electrons is then analyzed by a spectrometer to identify the atomic percent of elements present in the surface (1 - 10 nm usually) of the sample, chemical state of the constituent elements, and valence band structure. XPS measurements can be carried out using three different sources: monochromatic Al K-alpha and non-monochromatic Mg K-alpha and Ag K-alpha in the temperature range of 100 – 750 K. Besides, XPS has an option for the in-situ depth profile measurement. UPS can be used to characterize the valence band of electronic materials at and below room temperature.

Equipment Information

- Model & Make: M/s SPECS, Germany
- Year of Installation: 2009
- Resolution & Range: XPS energy resolution - 0.85 eV for Al K-alpha, 1.00 eV for Mg K-alpha, and 1.4 eV for Ag K-alpha; Minimum element detection limit is 0.5 % using XPS, Energy resolution of UPS is 131 meV
- Sample: Solid sample up to a maximum size of 7 mm x 7 mm and thickness of 5-10 mm. Material should not have volatile substances

UV-VIS-NIR Spectrophotometer

Research Area: Materials Characterization



Double monochromator with solid-state facility. Present equipment, which is highly sensitive and low-noise, can give accurate results for even minimum concentration measurements. To calculate the band gap of semiconductors, oxidation state & concentration of transition metals.

Equipment Information

- Model & Make: LAMBDA 750 & Perkin Elmer
- Year of Installation: 2019
- Application: For quantitative determination, reaction kinetic study, spectral recording, reflectance, and transmittance measurement of solid, liquid, and gel samples.
- Resolution and Range: 190 - 3300 nm
- Sample: Solid & Liquid

FT-IR Spectrometer System

Research Area: Surface Engineering

The instrument is useful in detecting the chemical bond vibration of organic and inorganic materials.
Obtained spectra help in identifying the chemical nature of the bond and the functional group present qualitatively.
Generally operated with KBr palate for powder samples. With available Smart accessories, we can record the reflectance spectra of solid powder, gel, and liquid materials.

Equipment Information

- Model & Make: NICOLET 5700 FTIR Spectroscopy, Thermo
- Resolution & Range: 400-4000 cm^{-1}
- Sample: Solid powder, Liquid & gel, Paint, emulsion

Differential Scanning Calorimeter (DSC)

Research Area: Materials Characterization

Differential Scanning Calorimeter (DSC) measures the amount of energy (heat) absorbed or released by a sample as it is heated, cooled, or held at constant temperature. It also performs precise temperature measurements. Its power-compensation technique yields higher sensitivity to detect a weak transition. The system has setups for carrying out measurements at low and high temperatures. The temperature ranges are: (i) High temperature: Room temperature to 725°C, and (ii) Low temperature: -50°C to 725°C. The measurements can be carried out in a controlled atmosphere (Ar, He, N_2).

Equipment Information

- Model & Make: Perkin Elmer, Model-PYRIS Diamond DSC
- Year of Installation: 2008
- Applications: Measurement of phase transition, activation energy, kinetics of phase transformation
- Sample: Metallic Strips: thickness few microns to 1 mm, width 2 mm, length 2 mm, few milligrams. Powders of a few milligrams

Magnetic Characterization System for Ribbons

Research Area: Magnetic Materials Characterization

Measurement Platform for the determination of AC magnetic characteristics of soft magnetic materials like soft ribbons & foils.

Equipment Information

- Model & Make: HyMAC, METIS
- Year of Installation: 2019
- Application: Soft Magnetic Measurement System
- Resolution and Range: 1-1000 Hz
- Sample: Ribbon /Foil (Thickness: 20-50 microns, width: 5 to 10 mm)

AC Core-loss Tester

Research Area: Soft Magnetic Materials and Electromagnetic Cores

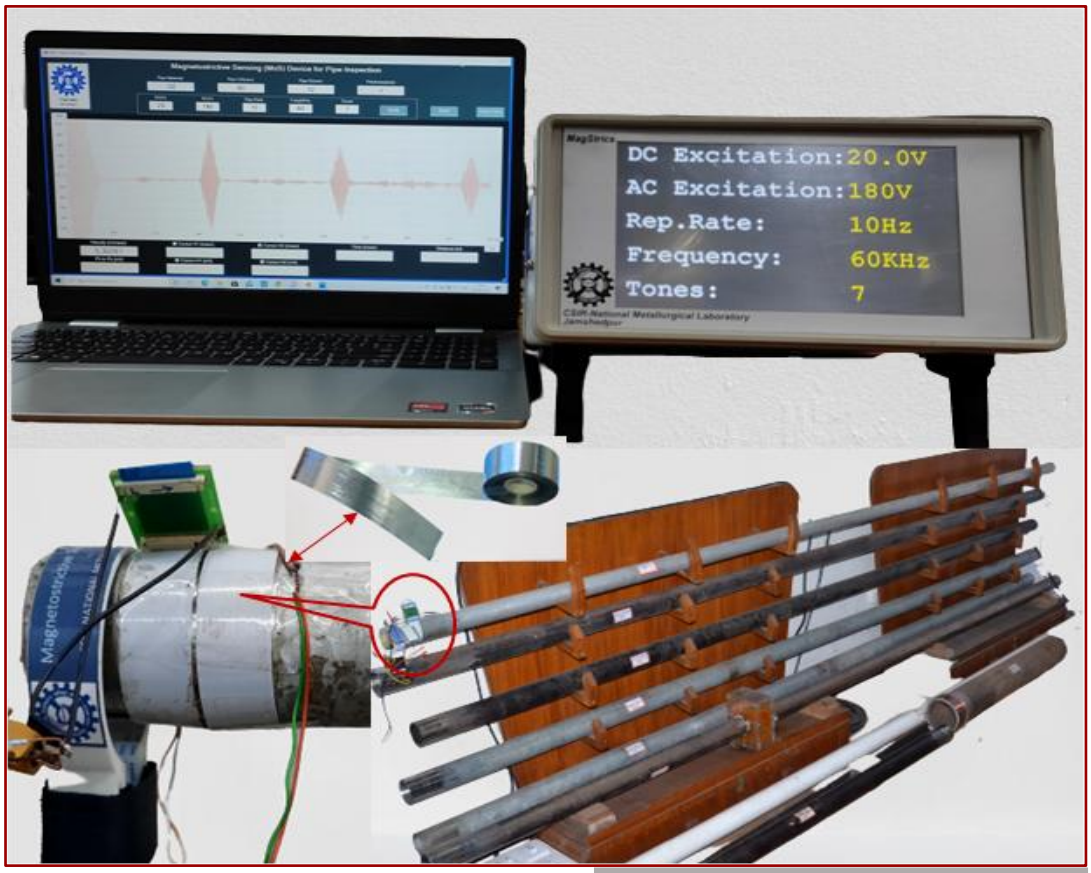
The AC core-loss tester can measure AC magnetic properties for soft-magnetic sheets, strips, powder cores. The setup offers dynamic measurement range between 10 Hz to 200 kHz. The system comprises Epstein frame measurement for Industrial sheets, single strip tester and winding based toroidal core measurements.

Equipment Information

- Model & Make: AMH-200 KS
- Year of Installation: 2017
- Application: Coreloss measurement
- Frequency: 10 Hz – 200 kHz
- Sensors: Epstein, single sheet, wound cores

MagStrics for Pipe Inspection

Research Area: Magnetic materials Characterization



The electromagnetic sensing device generates mechanical waves in pipes and also picks up reflected signals using amorphous soft magnetic ribbons as sensor elements.

Equipment Information

- Model & Make: MagStrics, CSIR-NML & Accelor Microsystems.
- Year of Installation: 2021
- Application: Detect defects in the pipe
- Resolution and Range: Minimum defect size: 0.5 mm
- Sample: Pipe

MagRays to Detect Carburization & Defective Welds

Research Area: Magnetic Materials Characterization

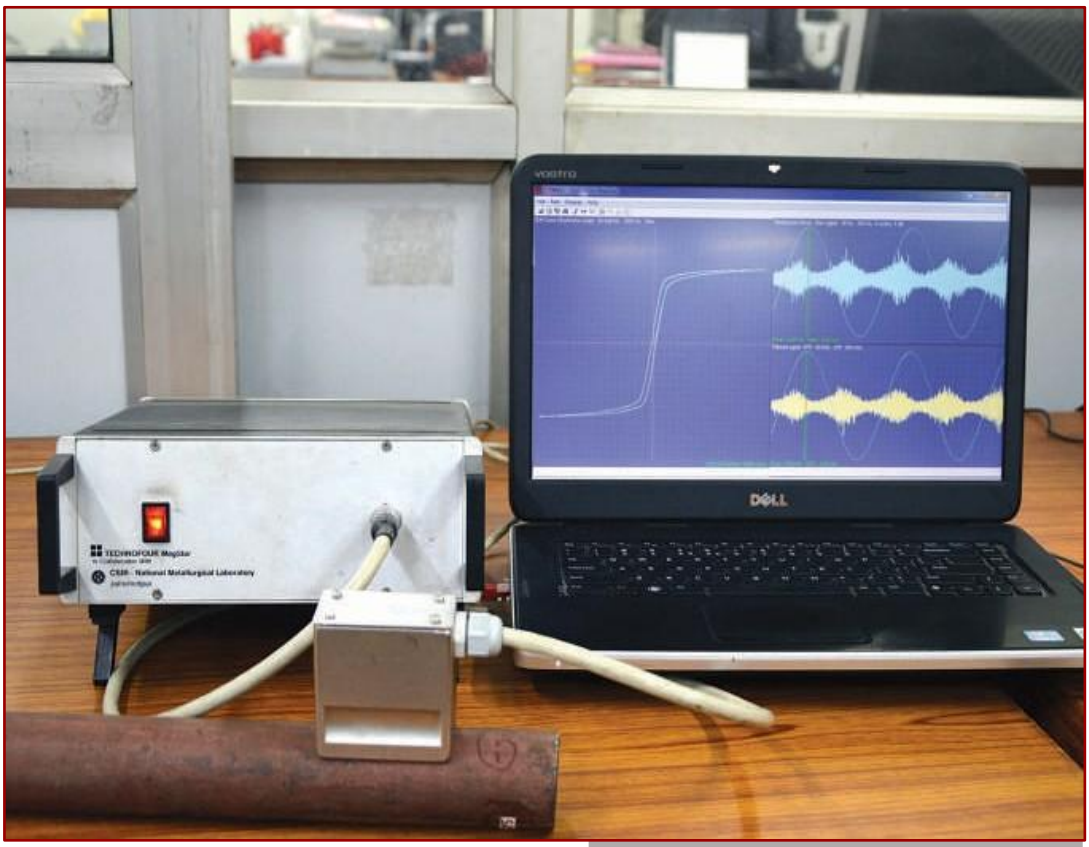
An electromagnetic sensing device based on change in impedance in response to feeble external magnetic field / magnetic phase.

Equipment Information

- Model & Make: MagRays, CSIR-NML & Accelor Microsystems
- Year of Installation: 2022
- Application: Detect carburization & defective welds
- Resolution and Range: For relative response studies
- Sample: Plate, Pipe

Portable Magnetic Sensing Device (Magstar)

Research Area: Non-destructive Evaluation



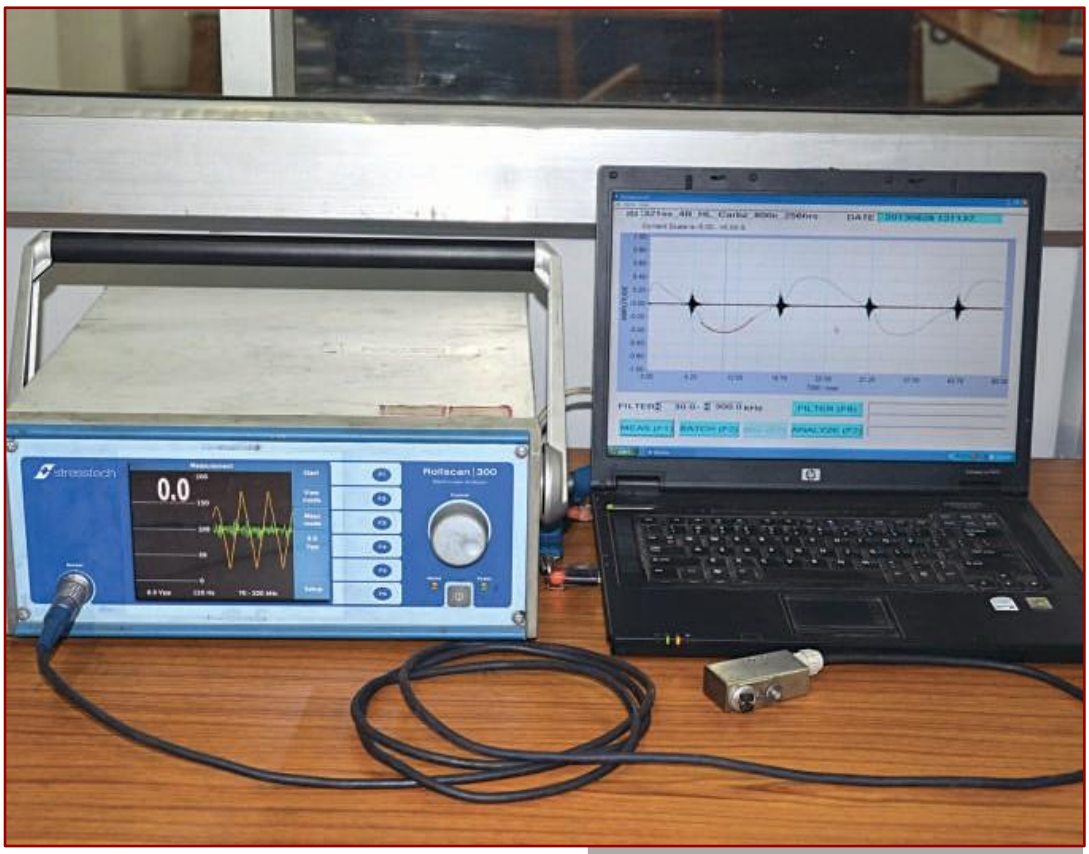
MagStar is a Magnetic NDE device developed jointly by M/s Technofour, Pune, and CSIR-National Metallurgical Laboratory, Jamshedpur. It measures Magnetic Hysteresis Loop (MHL) and Magnetic Barkhausen Emissions (MBE) using a single magnetizing probe. It has also the option for measuring MHL and MBE separately. The device is portable, light weight and has no-line measurement facility.

Equipment Information

- Model & Make: MagStar, CSIR-NML & Technofour, Pune
- Year of Installation: 2012
- Applications: MagStar sensor is used for transmitting signals of a frequency range of 50 mHz to 200 Hz for magnetizing the test object, as well as receiving MBE and MHL signals from the test object
- Sample: Plates: length 100 mm (min), width 10 mm (min), thickness 2 mm to 10 mm, Pipes: length 100 mm, diameter 50 – 100 mm, Rolls

Magnetic Barkhausen Emission Analyzer

Research Area: Non-destructive Evaluation



The Magnetic Barkhausen emission (MBE) is measured by the instrument Rollscan 300, which is a digital Barkhausen noise analyzer. This instrument can be used for the measurement of the Magnetic Barkhausen Emission (MBE) signal. The effect of residual stress, creep, and fatigue on MBE signals of ferromagnetic materials can be studied.

Equipment Information

- Model & Make: Rollscan - 300, America, Strentech
- Year of Installation: 2007
- Applications: Magnetic Barkhausen signal in ferritic steel, Iron, Cobalt, and nickel.
- Sample: Plates, Pipes, Tubes, Cylinders. The contact area required for the probes is 10 mm x 10 mm.

Contact Angle

Research Area: Surface Wettability and Surface Energy

Sample table horizontally movable (magnetic slide system) and adjustable vertically with precision mechanics.
High-performance 6.5-fold zoom lens
Integrated continuous fine focus and adjustable observation angle.
Video measuring system with USB 3 camera.
LED lighting with manual and software-controlled intensity, including automatic temperature drift compensation.

Equipment Information

- Model & Make: OCA15EC & Data Physics Instruments
- Year of Installation: 2009
- Application: Wetting and adhesion analysis
- Resolution and Range: 6.5X lens

BET Surface Area and Pore Size Analyzer

Research Area: Surface Engineering

Brunauer-Emmett-Teller (BET) surface area and pore size analysis based on the principle of N, adsorption-desorption method at liquid nitrogen temperature.
Present equipment offers determination of complete BET analysis includes BET surface area, mesopore size distribution, pore volume and average pore diameter.

Equipment Information

- Model & Make: NOVA 4000e, Ouantachrome, USA
- Applications: Minerals, Porous materials, ceramics, catalysts, and adsorbents
- Resolution & Range: Minimum surface area: 0.01 m^2/g and pore size range: 3.5 to 4000 A
- Sample: Inorganic solid in powder or granular form

Air Jet Sieve Shaker

Research Area: Powder metallurgy, Additive manufacturing

Equipment Information

- Model & Make: JS1100 & LabIndia Analytical, India
- Year of Installation: 2025
- Application: Powder processing
- Resolution and Range: 0.3-100 g & powders of size ranging 20-300 μm.
- Sample: Dry metal powders

Sieving gas atomized powders, and separating into different size ranges of 20, 32, 50, 70 & 100 μm, as per requirement in additive manufacturing /3-D printing.

Nano Indentation Unit

Research Area: Materials Evaluation

This XP naniondenter works in continuous stiffness measurement (CSM) and control load mode. Berkovich indenter is mainly used for the determination of mechanical properties and elastic-plastic behaviour of materials. It has nano vision and DCM attachment, also for related studies. The Load range in XP and DCM mode is given below

Equipment Information

- Model & Makel: Agilent: MTS Nanoindenter 'XP'
- Application: Nanoindentation is a method of measurement of the mechanical properties of a small volume of material as Hardness, Young modulus, Fracture toughness, creep, and load displacement curve. This is applicable for the mechanical properties of surfaces, coatings, multiphase materials, and layered materials.
- Resolution & Range: In XP mode 0-500 millinewton, In DCM mode 0-100 millinewton
- Sample: Thin-film coatings, Bulk solid materials

Vickers Hardness Tester

Research Area: Material Characterization

Equipment Information

- Model & Make: VH-50 MD,Chennai Metco, India
- Year of Installation: 2016
- Application: Material evaluation
- Resolution and Range: +/- 1 to 0.5 HV, 8-2900 HV
- Sample: Flat metallic with surface finish by 1200 grit SiC paper

Digital automatic Turret Vickers Hardness tester with touch screen display
Testing load: 1 kgf to 50 kgf
Distance of indenter to outer wall: 160 mm
Max. height of specimen: 180 mm
Testing force application method: Automatic loading and unloading

Universal Testing Machine

Research Area: Materials Evaluation

Equipment Information

- Model & Make: 25KS & Tinius Olsen, UK
- Year of Installation: 2011
- Application: Evaluation of mechanical properties
- Resolution and Range: Max. 25 kN loading
- Sample: Metallic materials

Evaluating mechanical strength and ductility through tensile and compressive testing of metallic samples.

Scratch Tester

Research Area: Materials Evaluation

The indenter drags on the surface of the sample with different loads. By using the traction force and normal load, one can find the coefficient of friction. The Rockwell indenter is used for the purpose

Equipment Information

- Model: DUCOM Scratch Tester TR-101
- Year of installation: 2006
- Application: For finding the coefficient of friction and scratch adhesion of the surface and coatings.
- Resolution & Range: Load 20-200 N, 1-20 N
- Sample: Any flat, smooth surface.

Pin-on-Disc Wear Tester

Research Area: Tribology

Pin-on-Disc wear tester is used to study the material loss due to frictional forces between the two moving bodies in contact. The system is capable of measuring simultaneously the friction coefficient and wear loss with time or sliding distance under varying load. The lubricability of the fluid can also be evaluated.

Equipment Information

- Model & Make: Wear & Friction Monitor, CM-9065, DUCOM, Bangaluru, India
- Year of Installation: 2008
- Applications: To evaluate material loss due to frictional forces
- Sample Size: 50 mm dia x 6 mm thick Pin Size: 2x2 to 4x4 mm^2
- Test Load: 0.2 N to 2 N
- Standard: ASTM G 99
- Sample: Samples should be flat, and they can be Ceramics, Polymers, Metals, and composites. Samples should not be toxic in nature and should not generate toxic gases during analyses. Nuclear materials and hazardous chemicals will not be used in this system

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Metal Extraction and Recycling

MER

CSIR-NML Jamshedpur

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350 KVA Vacuum Arc Furnace

Research Area: Melting

The Vacuum Arc Furnace at CSIR-NML with maximum power of 350 KVA and the facility of charging raw materials under vacuum. The desired vacuum level can be maintained at a set point in the range of 10 millibars to 900 millibars. This facility provides the necessary energy required for the reduction reactions up to a temperature of 1600˚C. The metallic component present in the ore, which can be evaporated and condensed, under the same reduction condition, can be separately recovered in a condenser connected with this furnace through a port. The quantity of raw material can be charged in the range of 200 – 400 kg depending upon the requirements. The slag and/or valuable by-products generated during the reduction reaction can also be tapped from the in-built tap hole at the end of the campaign. The unit is specially developed depending on the input materials and product requirements.

Equipment Information

- MOC: Mild steel with refractory lining
- Capacity: 200- 400 kg/batch
- Max Temperature: 1600˚C
- Vacuum Pressure: 10 - 900 mbar
- Applications: Melting at high temperature and negative pressure
- Sample: Lump ore

Sponge Magnesium from the dolomite/calcined dolomite can be produced at a pilot scale of 300 kg. The same facility is also tested for ferrochrome slag processing to produce the magnesium aluminate spinel refractory and high carbon ferrochrome alloy at 300-350 kg pilot scale under the feasible thermodynamic conditions.

Submerged Arc Furnace

Research Area: Process Metallurgy

The Battery of Submerged arc furnace at CSIR-NML consists of 50 kVA, 150 kVA, and 500 kVA units. These facilities are employed to study smelting reduction behaviour of a variety of raw materials including lean grade ores, waste materials, ORI, different types of reductant towards production of a wide spectrum of Ferro alloys namely Ferro Chromium, Ferro Manganese, Ferro Vanadium, Ferro Phosphorus, Ferro Silicon, Ferro Molybdenum, Ferro Titanium etc. While the smaller capacity units are being used to establish the technical feasibility of the process. The 500 kVA furnace has been successfully employed for pilot-scale trials to assess the techno-economic feasibility of a process. The data generated in these furnaces is directly used for commercial production.

Equipment Information

- Model & Make: Local make, BirleFCO
- Year of Installation: 1963
- Applications: Smelting Reduction
- Range: Up to 1 Ton
- Sample: All ferroalloys

Induction Melting Facilities

Research Area: Process Metallurgy

CSIR-NML has an excellent array of induction furnaces to produce/ develop specialty alloys. This array includes air induction furnaces with 5 to 20 Kg capacity and vacuum induction furnaces with 5 to 40 Kg capacity, equipped with alloy addition and tapping under vacuum. These furnaces can be used for the development of clean ferrous, non-ferrous, and intermetallic alloys. The furnaces are equipped with Optical Emission Spectroscopy for continuous chemical analysis of samples. CSIR-NML also has a 15 kW high-frequency vacuum induction furnace, suitable for melting/developing of very high purity ferrous as well as non-ferrous alloys casting under vacuum.

Equipment Information

- Model & Make: Inductotherm
- Applications: Alloy development
- Sample: Ferrous and Nonferrous alloys

Electroslag Refining Unit (ESR)

Research Area: Process Metallurgy

Equipment Information

- Model & Make: Indigenous with fully automatic control DC power source
- Applications: Removal of non-metallic inclusions and Sulphur content of alloy steel and non-ferrous metal.
- Sample: 40 mm diameter electrode of length ~ 1000-2000 mm.

Advantages of the ESR Process

- Control of chemical composition and its homogeneity
- Removal of micro- and macro-segregation
- Removal of Sand P to the desired level
- Sound ingot with no porosity, blow hole, pipe, etc.
- Increase of UTS, YS, ductility, and toughness
- Increase in weldability
- Increase in formability
- Control of microstructures

The electroslag refining (ESR) process is used to produce high-quality, clean steel. The slag is melted up to a temperature of 1700-2000°C by passing current, at which the consumable electrode is melted into the molten slag. Droplets of molten metal pass through the slag bath and are collected in a water-cooled mould (steel/ copper). The most remarkable process in metal refining is desulphurization. The removal of "S" from slag occurs through oxidation of "S" at the interface between slag and metal bath by atmospheric oxygen. Another important process in electroslag refining is the purification of the metal from oxygen and non-metallic inclusions, resulting in low macro-segregation and micro-segregation. This process is very effective in improving the quality of the steel. It produces metal of desire and homogeneous structure free from non-metallic inclusions and improved plasticity. Because of the higher purity and better structure of high-alloyed steels produced by electroslag refining, their deformability and weldability are also improved.

Battery Dismantling and Black Mass Generation Pilot Scale Facility

Research Area: Battery Dismantling

This is a battery dismantling cum processing facility which is capable of processing spent batteries to the tune of 1 ton/day and generates black mass (< 50 µm) devoid of copper, aluminium and iron contamination. This facility is available under HOT mode for recyclers and entrepreneurs.

Equipment Information

- Model & Make: STAR EXPORTS
- Year of Installation: 2023
- Application: Battery Dismantling for Black Mass
- Resolution and Range: < 50 µm Particle Size
- Sample: Spent Batteries

Mixer Settler Unit (MSU)

Research Area: Process Metallurgy

The mixer settler unit is used for the extraction and separation, enrichment/ purification of metals from aqueous leach solution using organic extractants in the continuous mode. The flow of aqueous and organic phases is maintained by the pump as per the requirement of the process in co-current/counter-current direction. Both phases are mixed in the mixer with adjustable speed stirrers and then separated in the settler unit with picket fences for the distribution of the dispersion over the whole cross-section of the settler. The process of metal extraction, scrubbing of impurities, followed by stripping of loaded metals, is carried out in different stages of the mixer settler unit. The regenerated organic is recycled in the system for the subsequent operation. It can be operated in the closed loop of the electrolytic cell of 9-10 L lab scale or 100 L and 600 L at pilot scale.

Equipment Information

- Applications: Two units of different capacities:
- Laboratory scale smaller capacity: Mixing volume 620 ml and settling volume 860 ml, No of stages: 30, Operates at 10 L/h of total liquid flow.
- Pilot scale capacity: Mixing volume 1000 ml and settling volume 6200 ml, No of stages 60, It can operate at max 60 L/h of total liquid flow. It is commonly used for pilot scale evaluation and demonstration of solvent extraction (SX) process condition. It was procured from MEAB Metallextraktion AB, Sweden.

Molten Salt Electrolytic Cell

Research Area: Process Metallurgy

Electrolytic cell are used to extract/ produce light metals, rare earth metals and able to produce light metal alloys directly from their salts. The specific features of electrolytic cell are cathode and anode at which electro-chemical reactions occur at high temperatures. The metal is deposited/ collected at cathode while anode acts as an inert electrical conductor. The cell is also used for electro-refining of an impure metal and produce a high purity metal at cathode. The fused salt electrolysis process is conducted at sufficiently high temperatures so as to keep both the electrolyte and the metal being produced in the molten state. The cell is operated in an inert atmosphere and the metal/ alloys can be collected continuously or in batch process. Using this cell light-metals like sodium, magnesium, aluminum, titanium, rare earths and alloys like Aluminum-Magnesium, Aluminum-Titanium, Aluminum-Lithium, Iron Neodymium, Magnesium-Cerium, etc can be produced directly from their salt.

Equipment Information

- Model & Make: Indigenous.
- Applications: Production of light metals, rare earths and light metal alloys directly from their salt.
- Resolution & Range: 500 ampere electrolytic cell with DAS facility, Rectifier 600 ampere, AC power source 1000 ampere.
- Sample: Powder salt

High Pressure Reactors

Research Area: Process Metallurgy

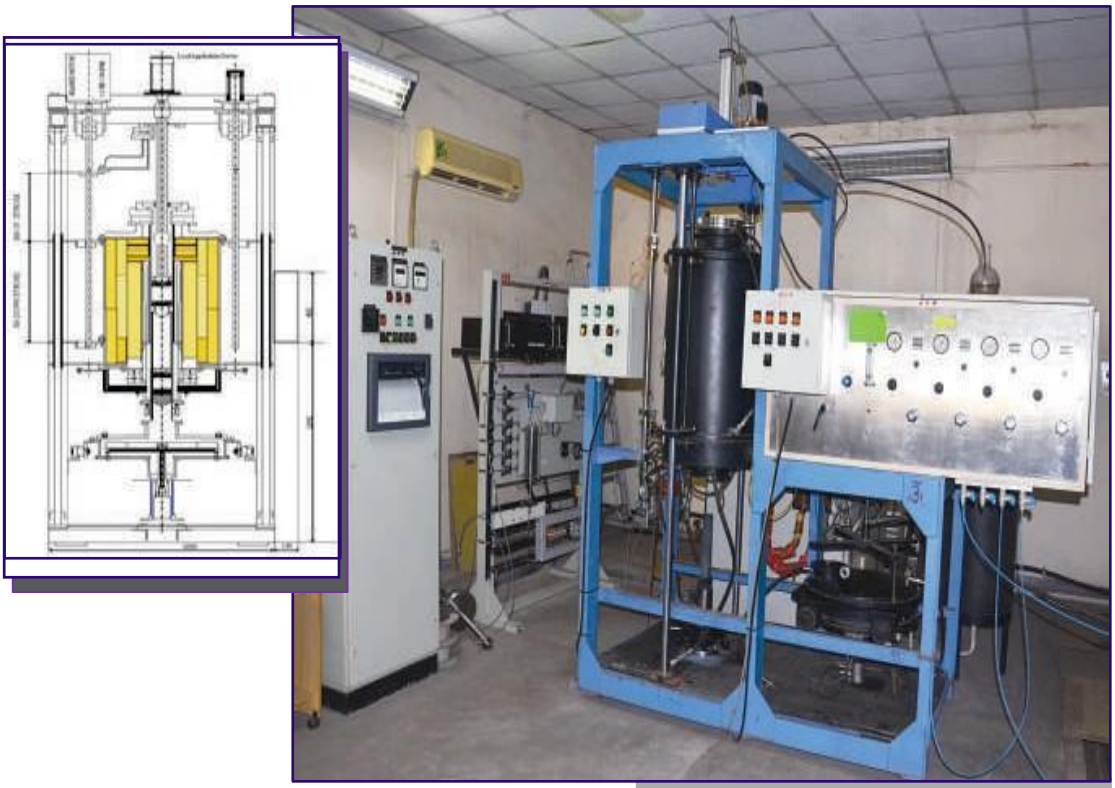
Equipment Information

- Applications: Dissolution and precipitation reactions at high temperature and pressure conditions under different atmosphere (reducing, oxidizing and inert).
- Sample: Powder sample

To carryout dissolution and precipitation reactions at high temperature and pressure conditions, autoclaves of different capacities are available at CSIR-NML. Most of them are from PARR Instrument Company Ltd. USA and Hoffer, West Germany. The autoclaves are also suitable for carrying out reaction under reducing, oxidizing and inert atmosphere. The capacity, MOC and maximum temperature and pressure limits for the autoclaves are given below.

High Temperature Softening-Melting (HTSM)

Research Area: Process Metallurgy



The softening-melting properties of ferruginous material have an important influence on the furnace operation, including pressure drop, distribution of hot ascending gas, fuel rate, hot metal quantity, etc. Accordingly, it is desirable to assess the suitability of the iron-bearing raw material before its use in the blast furnace. The HTSM equipment tests the ferruginous raw material in the laboratory under blast furnace simulated conditions, and the parameters that can be calculated/ inferred by the test are softening temperature (Ts), melt down temperature ™, resistance to gas flow, bed shrinkage, and % Non-dripped material (NDM)

Equipment Information

- Model & Make: Indigenous Con Com Consultants, Ranchi
- Resolution & Range :
- Operating temperature: 1600°C (Max), Sample bed: Diameter - 48 mm, Sample size - 8-10 mm, Weight of sample - 250 to 300 gms
- Gas input: Process gas - 6 1 pm (30% CO + H, + N_2), CO_2 if needed, and rest N,
- Gas flow regulation indication - Mass flow controller Top Pressure - Up to 2 Kg/cm'
- Sample: Solid materials

High Pressure Autoclave - 500 Liter

Research Area: Leaching

The autoclave is designed for high-pressure leaching operations at optimal temperature conditions. External heating and cooling systems are provided to ensure precise temperature regulation. A heavy-duty motor, powered by a three-phase electrical supply, is integrated to enable rotational movement, promoting uniform mixing and effective leaching. The autoclaves are suitable for carrying out reaction under reducing, oxidizing and inert atmosphere.

Equipment Information

- MOC: Inner layer of titanium with stainless steel as outer layer
- Capacity: 50 - 100 kg/batch
- Maximum Temperature: 250˚C
- Working volume: 400 Liters
- Pressure: 50-100 Bar
- Applications: Dissolution and precipitation reactions at high temperature and pressure under different atmospheres
- Sample: Powder

Titanium Autoclave - 30 Liter

Research Area: Leaching

The autoclave is used for high-pressure leaching processes at optimal temperatures. External heating and cooling systems are integrated to maintain precise temperature control during operation. The autoclave is equipped with a heavy-duty motor for rotation, powered by a three-phase electrical supply, enabling uniform mixing and efficient leaching. The capacity, MOC and maximum temperature and pressure limits for the autoclaves are given below:

Equipment Information

- MOC: Titanium vessel with stainless steel as outer layer
- Capacity: 2-5 kg/batch
- Maximum Temperature: 250˚C
- Working volume: 15-25 Liters
- Pressure: 20-30 Bar
- Applications: Dissolution and precipitation reactions at high temperature and pressure under different atmospheres
- Sample: Powder sample

Leaching Pilot Plant

Research Area: Leaching

The Leaching Pilot Plant is designed for the hydrometallurgical processing of metal-bearing materials through controlled leaching operations. The plant is equipped with reactors and process vessels constructed from corrosion-resistant materials, ensuring compatibility with a wide range of acidic and alkaline leaching solutions. Heating and agitation systems are integrated to maintain optimal reaction conditions and ensure thorough mixing of the material and leachant. The facility also includes filtration, solid-liquid separation, and solution handling units, allowing for efficient recovery of leach liquor. Precise process control systems enable monitoring of temperature, pH, and pressure to ensure consistent performance. The capacity, MOC, and maximum temperature and pressure limits for the leaching plant are given below:

Equipment Information

- MOC: Mild steel and Stainless steel
- Capacity: 100 - 200 kg/batch
- Maximum Temperature: Max. 150˚C
- Pressure: Atmosphere
- Applications: Leaching under different acid media.
- Sample: Powder sample

Attrition Mill

Research Area: Fine Milling/Mechanical Activation

Equipment Information

- Model & Make: PE075
- Year of Installation: 2001
- Applications: fine grinding, mechanical activation
- Sample: Feed size up to 150 microns

Suitable for fine (wet) grinding of brittle materials like ores, minerals, ceramic raw materials, slag, fly ash, dyes and chemicals etc. Milling can be carried out at elevated temperatures (up to 80°C)

Eccentric Vibration Mill

Research Area: Fine Milling/Mechanical Activation

Eccentric vibrating mill (Model : ESM234-1bs, Siebtechnik, Germany) is a highly efficient grinding mill in which comminution is brought about by impact and abrasive action between grinding bodies and between the grinding bodies and mill container wall. Accelerated /efficient grinding in the mill results from the multi-axis vibratory movement of the mill container (circulatory, elliptical and linear). The mill is suitable for dry and wet fine grinding brittle materials of all degree of hardness, such as ores, low grade hard metal raw materials, ceramic raw materials, slag, fly ash, dyes and chemicals. The mill can be used for mechanical activation as well as dry homogenizing of powders and doping agents. The maximum feed particle size can be up to 20 mm. Size reduction down to 0-5 micron is possible. Up to about 1-2 kg material can be ground per batch

Equipment Information

- Model & Make: Model: ESM234-1bs, Siebtechnik, Germany
- Year of Installation: 2006
- Applications: High energy milling
- Sample: Brittle materials up to 20 mm size

Rotary Kiln

Research Area: Pyrometallurgy

Rotary kiln furnace is operating at 1300-1400°C with a throughput of 100 Kg per hour for calcining the different types of raw materials.

Equipment Information

- Year of Installation: 2005
- Resolution & Range:
- Kiln Working Temperature: Maximum 1400°C (50% of Kiln Length)
- Burner system: Compressed air-assisted pressure Jet Burner with atomizer
- Kiln Dimension: Shell I.D. : 900 mm, Overall Length: 8800 mm, Rotational Speed: 0.6 RPM to 2 RPM
- Refractory Lining: 115 mm thick magnesite refractory brick suitable for 1400°C
- Temperature measurement: At 3 locations along the length using S-type (Pt-Pt/Rh) thermocouple with sensors & Transmitter to a Digital Temperature Indicator

Down-Draft Sinter Pot

Research Area: Pyrometallurgy

A down-draft sintering pot is used for a small-scale sintering study of ore fines. It is cylindrical in shape and made up of a mild steel plate lined with magnesite ramming mass or a suitable refractory capable of withstanding both temperature and atmosphere of the chamber. It has 380 mm height and 160 mm diameter with a capacity of about 10 kg/batch for iron ore mix. It has a charging and ignition facility at the top and the sinter discharge from the side wall. Five thermocouples at different heights of the bed provide flame front movement, and one more for exit gas temperature measurement. Suction from the bottom with a measuring facility. It is facilitated with a digital measuring system of the inlet air from the top. There is the provision of oxygen or other gas injection from the top. It is integrated with a pelletizer, which helps in micro pelletization of fines prior to sintering. Pressure drop in the bed is also measurable by the compound pressure gauges at the inlet and outlet.

Equipment Information

- Model & Make: Local vendor
- Year of Installation: 2010
- Resolution & Range: Capacity: 10-12 kg/ batch for iron ore mix
- Sample: Fines and micro-pellets of ores

Rotary Oxidation Furnace

Research Area: Thermal Oxidation

The rotary oxidation furnace is designed for the thermal oxidation of metal powders and other materials under controlled temperature and atmospheric conditions. The furnace operates on a continuous rotary mechanism, ensuring uniform heat distribution and consistent material movement throughout the process. Its construction includes a zig-zag stainless steel (SS-310) rotating chamber, supported by a robust 10 mm thickness (SS) outer shell. Heating is achieved through externally mounted electric elements, and temperature control is maintained through advanced PID systems. The furnace is equipped with adjustable speed rotation, allowing precise control over residence time and material exposure. It also features an integrated gas injection and exhaust system to handle oxidation atmospheres and remove by-products safely, supported by a fume extraction unit. The capacity, MOC and maximum temperature and pressure limits for the rotary oxidation furnace are given below:

Equipment Information

- Model and make: VNV Eco Projects Private Limited
- MOC: Stainless steel
- Capacity: 20 - 40 kg/day
- Maximum Temperature: Max. 1050˚C
- Pressure: Atmosphere
- Rotation speed: 0 - 4 RPM
- Lifting & tilting: Hydraulic jack
- Applications: Oxidation/roasting at high temperature under different atmospheres
- Sample: Powder sample

High Temperature Fluidized Bed Reactor

Research Area: Process Metallurgy

Equipment Information

- Model & Make: Montech Instruments, Chandigarh
- Applications: To study the reduction of ores to metallic state using gases like CO and LPG and neutral gases like N, and argon.
- Resolution & Range: Up to 1200°C
- Sample type: Solid materials

The high-temperature fluidized bed reactor is a sophisticated pilot unit for experimental studies of reactions involving the reduction of ores to the metallic state using gases like CO and LPG, and neutral gases like N and argon. The gas flow may be metered and manually controlled with state-of-the-art mass flow meters giving direct digital output of mass flow rate, pressure, and temperature. Over an experimental run, the gases used may be totaled. The outflow may be sampled and separately analyzed. The gases are mixed and may be preheated before entry to the reactor. This hot gas mixture is further heated to the process temperature by passage through a bed filled with alumina balls in the INNER TUBE that has the Zirconia distributor plate at the top. The ore bed is on the distributor plate, and gases flowing through it fluidize it. The inner tube with the distributor plate is inside the main reactor tube. The fluidized ore column is roughly in the middle of the hot reaction zone of the three-zone main furnace. The zones can be independently controlled /trimmed to achieve a suitable temperature profile in the main reactor. The reaction mixture can be sampled by a unique device inserted from the top flange of the reactor into the reaction zone. Full protection against overpressure in gas lines is achieved by using special safety valves that have adjustable trip points presently set to 20 psi. Non-return valves are used in each gas line to prevent reverse flows. The reacted contents can be downloaded into the lower chamber by sliding open the special plate valve at the bottom. This chamber is a double-walled water-cooled housing with two thermocouples for temperature monitoring and a viewing window for observation. This window has tempered glass.

Pusher-type Reduction Furnace

Research Area: Reduction and Roasting

The pusher-type reduction furnace is designed for the reduction and roasting of heavy metals, such as tungsten, under optimal pressure and temperature conditions. The furnace is constructed with refractory bricks and a stainless steel outer body, ensuring durability and thermal insulation. It features integrated heating and cooling systems that can be operated in both automatic and manual modes. Material is charged into the furnace using a movable tray on one side and discharged via a cooled tray on the opposite side, allowing for continuous processing. A dedicated gas station provides controlled gas injection and includes a system for safe removal of generated gases, supported by an efficient fume extraction facility. The capacity, MOC and maximum temperature and pressure limits for the Pusher type reduction furnace are given below:

Equipment Information

- Model and make: Thereleck Pvt. Ltd.
- MOC: Inner layer of titanium with stainless steel as outer layer
- Capacity: 30 - 50 kg/day
- Maximum Temperature: Max. 1000˚C
- Working volume – 18-20 trays/ batch (each tray capacity =2 kg powder)
- Pressure: Atmosphere
- Applications: Reduction/roasting at high temperature under different atmospheres
- Sample: Powder sample

Pilot Plant for Brick, Paver m Briquett

Research Area: 12 MT Per Shift Capacity Block & Briquette

Fully automatic Pilot Plant for block, brick, briquette making

Equipment Information

- Model & Make: AIRCON Handling system
- Year of Installation: 2012
- Resolution and Range: 12 MT per shift
- Sample: Any shape as per the die

Hydraulic Press

Research Area: Compaction of Powder Samples

Equipment Information

- Model & Make: BELL HYDRAULICS
- Year of Installation: 2021
- Application: Preparation of compact samples of powdery material
- Resolution and Range: Semiautomatic 50 MT
- Sample: Cylindrical, Cubical, or any shape can be prepared

Semiautomatic type hydraulic press of capacity 50 MT. Bottom pressing type in operation

Motorized Biological-Cum-Materials Research Microscope

Research Area: Materials, Alloy, and Biological Characterization

Equipment Information

- Model & Make: M/s LEICA, Germany
- Year of Installation: 2012
- Resolution & Range: 100 W Hg lamp, Motorized focus and automated fluorescence, with auto-sectioning, montage
- Sample: Solid sample up to a minimum size of 5 mm x 5 mm and thickness ~ 5 mm. Powder samples of any type are also suitable. Can sectionally view the samples across the Z-axis, suitable for some uniquely shaped specimens. Powder samples don't have precaution of polishing, though it will be advantageous in that mode. In-situ experiments can be viewed at the microscale and recorded. An image of incident and transmitted light can be overlaid for greater detail.

This material-cum-biological integrated microscope is the first of its unique facility installed in India by Leica at CSIR-NML, which can help the user to view, identify, and characterize samples like materials, powders, alloys, coatings, microbial cells, and their attachments, etc. With motorized z-focus, motorized and coded 7x nosepiece, fully automated transmitted light axis, and fully automated 5x or 8x fluorescence axis, the automated Leica DM6000BM provides all transmitted light contrast methods, including the world's first fully automated Differential Interference Contrast (DIC). Unique is the ability to recall a particular contrast method with an objective, i.e., the system can recall DIC in combination with 100x magnification, which provides reproducibility. The motorized Z drive offers the convenience of automatic parfocality adjustment, saved focus levels, and automated positioning of Z levels, multi-focus, auto montage, and 3-D reconstruction. It is ideal for metallurgical and biological samples viewing under polarized and differential interference suites. For biological samples, the microscope shall be very useful in clearly demarcating the inorganic matter from the microbes, and alternatively, shall render a clearer view of the material surfaces. Additional modules serve the purpose of classification of particles on filters; automatic steel inclusion rating of stainless-steel alloy; surface imaging and layer thickness in corrosion and coating evaluation; grain analysis; identifies up to 10 different phases represented in an image by colour or contrast; live XYZ shooting and recording.

RI-RDI Apparatus

Research Area: Pyrometallurgy

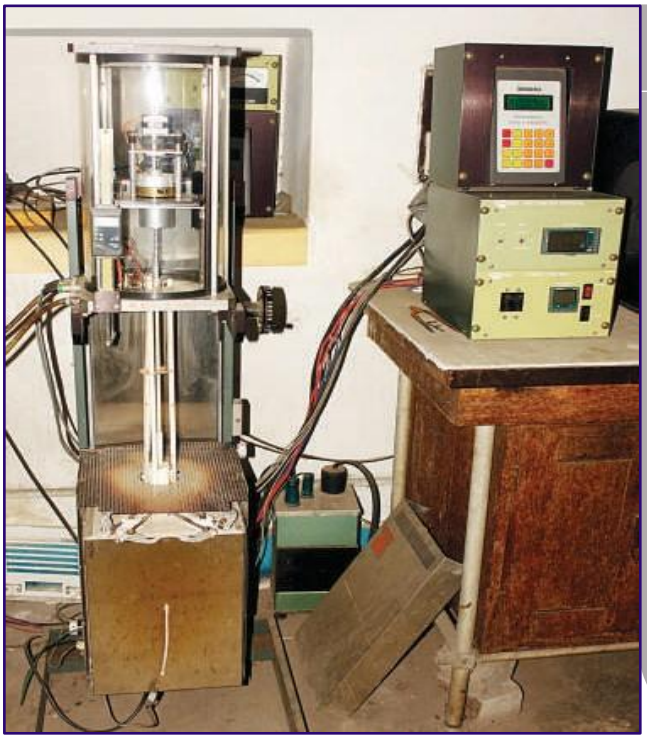
Quality and suitability of using iron ore/agglomerates as iron burden can be estimated prior to its charging in iron making industries. The tests simulate the actual operating conditions.

Equipment Information

- Year of Installation: 2006
- Sample: lump iron ore, pellet, sinter and briquettes

High Temperature Viscometer

Research Area: Pyrometallurgy



Equipment Information

- Model & Make: Brookfield LV DV- III+ & Theta Scientific-USA
- Year of Installation: 2003
- Resolution & Range:
- Temperature range: from ambient to 1550°C
  Viscosity range: up to 5x 10E5 cP (centiPoise)
- Sample: molten metal, slag, flux, glass, oil & coal ash

Evaluation of thermo-physical properties of an industrial system is more important to decide the quality of the product. For example, in a continuous casting process, the properties of raw mould powder, such as thermal conductivity, viscosity, liquidus temperature, break temperature, enthalpy, melting temperatures, density etc., has much impact on the quality of the product. Among all these properties, the viscosity, softening/melting temperature of molten slag/metal/ mold powder, plays a vital role at high temperature. The viscosity of fluids varies with temperature due to their change in crystal structure. Viscosity of slag/metal/mold powder/flux/alloys is measured at different temperatures in the viscometer to determine the softening and melting behaviour of the given material. The viscometer is completely controlled through the automatic DilaSoft I software, and all data will be saved in standard ASCII format to import into any analysis program. Systems can be measured: pure metals, alloys including ferrous and nonferrous systems, slag includes ironmaking and steelmaking slag and nonferrous slag, glass, oil, and other liquids.
Principle of measurement: Rotating bob method

Thermal Conductivity Tester

Research Area: Materials Characterization

Equipment Information

- Model & Make: TCT-426 & NETZSCH
- Applications: Thermal Conductivity measurement of Refractories
- Resolution & Range: RT to 1500°C
- Sample: Refractory brick, size- 230x115x65 mm

Thermal conductivity is the most important thermophysical parameter for characterization of the thermal transport properties of a material or component, especially for refractories which are normally used at high temperature.
The hot-wire method is an absolute method for direct determination of the thermal conductivity, based on the measurement of the temperature increase of a linear heat source/hot wire (cross wire technique) or at a specific distance from a linear heat source (parallel-wire technique). The hot wire and thermocouple are embedded between two test pieces, which make up the actual test assembly. The time-dependent temperature increase after the heating current is switched on is a measure of the thermal conductivity of the material being tested. Another variation, the so-called “Platinum Resistance Thermometer Technique” or “T® Technique”, is described in ASTM-C 1113. Here, an integral temperature measurement is carried out over the entire length of the hot wire; i.e., the hot wire is both a heat source and a temperature sensor at the same time. The TCT 426 thermal conductivity tester enables the use of all three of the methods described in easily interchangeable, pre-wired measuring frames. The controller unit is connected with the measuring frame inside a SiC Thercouple bearing furnace. With this instrument Thermal conductivity of refractories can be measured at room temperature as well as high temperature (1500°C)

Automatic Compression Testing Machine

Research Area: Compressive Strength, Split Tensile Strength Measuring

Equipment Information

- Model & Make: HEICO \
- Year of Installation: 2021
- Application: Compressive and Split Tensile Strength Testing
- Resolution and Range: 2000 kN Capacity
- Sample: Cubical and cylindrical samples

Automatic Compression Testing Machine of 2000 kN useful for measuring compressive strength , split tensile strength.

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Minerals Processing

MNP

CSIR-NML Jamshedpur

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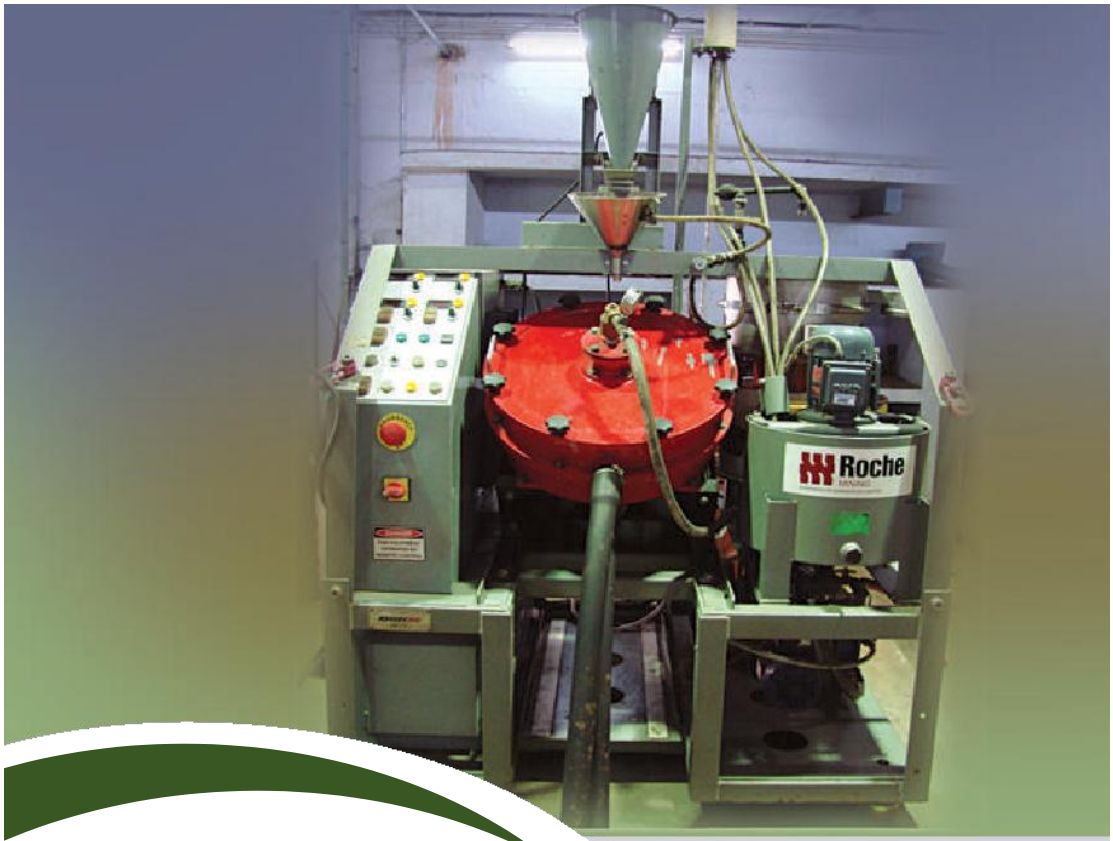
Centrifugal Jig For Separation of Fine Mineral Particles

Research Area: Mineral Processing



Kelsey Centrifugal Jig is an enhanced gravity separator which allows separation of mineral particles in the fine size ranges. The Kelsey Jig is based on the principles of conventional mineral jig but operates at g-force 100 times that of gravity. This results in improved separation efficiency particularly in fine sizes. The feed particle size to be treated by Kelsey Jig should be < 500 micron.

Equipment Information

- Model & Make: J200 Mobile Test Unit & M/s Roche Mining (MT) Pty. Ltd., Australia
- Year of Installation: 2006
- Resolution & Range: g-force up to 100 times
- Sample: Particle size < 500 microns

Impact Hammer Mill

Research Area: Mineral Processing

The impact hammer mill generates uniform product size with less fines due to shatter fracture. It can treat all types of ores at about 200 kg/h in continuous manner. The top size of the feed material is 100 mm. It can generate a product of less than 5 mm size. It has provision to introduce the feed through a vibratory feeder. The grate opening at the discharge can also be changed to restrict the top size of the product. The rotor speed can also be controlled from the control panel.

Equipment Information

- Model & Make: Subhadra Engineering Works, India
- Year of Installation: 2009
- Resolution & Range: 200 kg/hr
- Sample: 40-100 mm

Induced Roll Magnetic Separator

Research Area: Mineral Beneficiation

Induced Roll Magnetic Separator develops high-intensity magnetic fields and is capable of removing weakly paramagnetic particles. The roll onto which the ore is fed, is composed of phosphate steel laminates compressed together on a non-magnetic stainless steel shaft. By using two sizes of lamination, differing slightly in outer diameter, the roll is given a serrated profile which promotes high field intensity and gradient. Field strengths up to 2 Tesla are attainable in the gap between the feed pole and roll. Non-magnetic particles are thrown off the roll into the tailing compartment, whereas the magnetic particles are gripped, carried out of the influence of the field, and deposited into the magnetics compartment.

Equipment Information

- Model & Make: RL9011, Reading, M/s Mineral Technologies, Australia
- Year of Installation: 2013
- Resolution & Range: Magnetic Intensity Range: 2 Tesla (20,000 Gauss), Size Range: -1 mm to 0.075 mm.
- Sample: Dry sand or ore fines

This is widely used to treat beach sands, wolframite, tin ores, glass sands and phosphate rocks for recovery of paramagnetic minerals or removal of magnetic impurity. The separation is carried out in dry condition.

Advanced Flotation Cell

Research Area: Mineral Beneficiation

Equipment Information

- Model & Make: FC, M/s Insmart, Hyderabad
- Year of Installation: 2014
- Mode of operation: Batch type, Particle size: - 500 + 10 microns
- Sample: Solid ore or fines

Advanced Flotation cell brings about separation of hydrophilic from hydrophobic particles based on the physico-chemical properties. The minerals are kept in suspension by the rotation of the impeller. The equipment has an inbuilt air flow generator to provide air bubble and its control through a rotameter. There is provision for control and digital display of rpm of impeller. The movement of the platform containing the cell is controlled by a hydraulic system. Flotation cell is useful for concentration of a wide range of metallic minerals such as platinum, nickel, gold-hosting sulphides, sulphides of Cu, Pb and Zn, oxides such as hematite cassiterite, oxidized minerals such as malachite and cerrussite and non-metallic minerals such as fluorite, phosphates and fine coal.

Dry High Intensity Magnetic Separator (DHIMS)

Research Area: Mineral Beneficiation

Each ore mineral has definite and different magnetic susceptibilities which is exploited through magnetic separation to separate either valuable magnetic minerals from non magnetic gangue minerals or magnetic impurities from valuable non-magnetic minerals.

The high intensity magnetic separator essentially consists of vibratory feeder, a magnetic roll driven by a variable speed motor, a belt over the idler and compartment for collection of magnetic and non-magnetic products. This type of separator uses powerful permanent magnet using rare earth metals. The advantages of this equipment is that it is low power consumption only to drive the roll, variation of field intensities through change of belt and no direct roll- particle contact. It is used for the dry processing of low grade hematitic or goethetic iron ore for removing the non-magnetics with less iron value, processing of beach sand to recover the paramagnetic materials and other minerals.

Equipment Information

- Model & Make: Permroll, M/s Ore Sorters (North America) Inc.
- Year of Installation: 1993
- Resolution & Range: Capacity: 100 kg/hr, Feed size: - 30 mm + 1 mm
- Sample type: Dry solid sample

High Tension Separator

Research Area: Mineral Beneficiation

Equipment Information

- Model & Make: Carpco Inc, USA
- Year of Installation: 1991
- Sample: The sample should be dried and screened to remove – 75 µm. If the sample has a wide size range, then it has to be classified into a closed size range.

High tension separation utilizes the differences in electrical conductivity between the various minerals in the ore feed. It utilizes a grounded roll to transport feed material through the high-voltage ionizing field (corona) where particles are charged by ion bombardment. Conducting particles pass their charge to the grounded carrier electrode (roll) and are therefore free to be thrown from the roll by centrifugal and gravity forces. Non-conducting particles are pinned to the carrier electrode and are transported further around the roll periphery, where they drop from the electrode surface, either because their charge dissipates or by any mechanical means. This equipment can be used for the processing of beach sand, the recovery of metallic components from electronic waste, and other minerals.

Laboratory Instrumented Jig

Research Area: Mineral Beneficiation

The standalone pneumatically controlled laboratory instrumented jig is intended for the gravity separation of ores, minerals, and coals. Under-bed air pulsation triggers stratification of ores such as iron, coal, etc., into varying density fractions. The stratification of randomly mixed ore particles in sync with the respective density of target particles in a jig is based on the well-known principle of sorting by the water flow, which pulsates vertically through the layer or bed of material being processed, and principles of settling. The water movement is generated by disc valve-controlled jigging air, which acts on the water perpendicular to the direction of its transit from the bottom of the jigging bed.

Equipment Information

- Model & Make: M/s MBE Coal & Mineral Technology GmbH, Germany
- Year of Installation: 2013
- Resolution & Range:
- Capacity: 100 - 150 kg of materials per batch depending upon the feed material Feed Size : 40 mm - 0.5 mm
- Sample: Solid lumps or fines of iron ore, coal and metal slag

A homogeneous feed distribution relative to quantity, density, and grain size across the cross section of the machine width is essential for the high accuracy of separation in a jig. The process results in the concentration of the heaviest materials in the lower-most layers as opposed to the concentration of the lighter particles at the surface.

Field of application: For separating ore, minerals, coal, and slag of a grain size between 40-0.5 mm in ore and minerals.

Air Table / Fluidized Bed Separator System

Research Area: Mineral Beneficiation

Fluidized Bed Separator/ Air Table is primarily utilized for separation of dry uniformly sized solid particles with differential specific gravity. Air-pulsed fluidization is triggered by air stream and guided into the separating deck. The principle of separation is defined as follows:

The harmonic motion of the deck/deck screen in combination with operating variables such as deck inclination, eccentrics, amplitude, et al, sets in motion the separation of particles' mix. The characteristics of differential specific gravity of the particles' mix is exploited with efficacy, for three fraction segregation (viz., heavy, middlings and light) on the deck surface, which gets subsequently diverted for collection in product launders, positioned at the edges.

Equipment Information

- Model & Make: Q8 Magellan Bruker GmbH
- Year of Installation: 2009
- Application: Elemental analysis of all types of metals
- Resolution and Range: 10 mg/Kg - 99.90 %
- Sample: Disc shape

This equipment developed in pursuit of effective dry separation methodology contributes immensely in R&D Application for separation of impurities from iron ore, wolframite, etc., especially from coal, in mineral beneficiation process. The equipment also has immense value addition potential in recovering valuable products from beach sand minerals (ilmenite, sillimanite, zircon, etc.)

Spiral Concentrator

Research Area: Mineral Beneficiation

Spiral Concentrator is a gravity based concentrating device, that separates low density granular and sandy particles from high density material. Separation principle is based upon a combination of the solid particle density as well as the particle's hydrodynamic properties (e.g. drag). Spiral gravity concentrators are made up of a number of troughs which are wound around a central column in the form of a helix. The advantage of spiral concentrators is that they have no moving parts, the spiral unit is a non-powered item, relying solely on gravity feed. The feed range, in percent solids, to a spiral ranges from 10% solids up to 30% solids. Spiral trough has 3 auxiliary polyurethane slide splitters to extract a primary concentrate, and vertical polyurethane blade splitters at the base of the troughs which direct concentrate, middling and tailings products into separate product channels. The slide splitter is adjusted to extract high grade concentrate into a concentrate channel at the inner edge of the spiral trough.

Equipment Information

- Model & Make: Mineral Spirals including Fine Spiral (FM 1), MD Mineral Technologies, Australia
- Year of Installation: 2007
- Capacity: 200 - 500 kg/hr of materials, depending upon the characteristics of feed materials
- Feed Size: 2 mm - 0.03 mm
- Sample: Solid ore fines

Wet High Intensity Magnetic Separator (WHIMS)

Research Area: Mineral Beneficiation

Wet High Intensity Magnetic Separator (WHIMS) is utilized in separating magnetic or weakly magnetic from non-magnetic materials. Magnetic fields of varying intensity may be deployed for selective separation of materials having different magnetic susceptibility. It is utilized for separation of hematite and goethite in beneficiation of iron ores, ilmenite, wolframite and chromite and other paramagnetic minerals from the associated gangues. The process employed is wet phase and intended for processing relatively finer particles.

Equipment Information

- Model & Make: Minimag (Gaustec), M/s Allmineral Asia Pvt. Ltd, Belgium
- Year of Installation: 2013
- Resolution & Range:
- Capacity: up to 300 kg/hr iron ore per feed point with 2.5 mm matrix boxes. Particle Size: Particles< 3 mm feed size
- Magnetic Intensity: Adjustable up to 18000 Gauss @t 1.5 mm gap (cobber) resp. 14800 Gauss @1.5 mm gap (concentrator)
- Sample: Ores containing hematite, goethite, magnetite, chromite, ilmenite, wolframite as valuable minerals along with associated gangues

Knelson Concentrator

Research Area: Mineral Beneficiation

Knelson Gravity Concentrator is a Continuous Centrifugal Gravity Concentrator which utilizes the fluidization technology for high-mass yield recovery application. Knelson Concentrator is used primarily for bulk recovery of gold, PGE and various base metals and industrial minerals such as Copper, Chromite, Iron ore & Coal. It uses centrifugal force field to enhance the settling kinetics of fine particles to improve their recovery.

Equipment Information

- Model & Make: KC-CVD6, FLSmidth
- Year of Installation: 2014
- Resolution & Range:
- Feed Capacity: 0.6-2.2 tons/h

Operating G force: 30-90 g

Vertical Ring and Pulsating High Gradient Magnetic Separator

Research Area: Mineral Beneficiation

Slon 500 Vertical Ring and Pulsating High Gradient Magnetic Separator (Slon 500 VPHGMS) is an advanced equipment for separation of paramagnetic minerals. It combines magnetic force, pulsating fluid and gravity forces for separation affine grained paramagnetic minerals. The unique feature of pulsating mechanism and matrix design leads to improved performance over conventional magnetic separator. The equipment finds applications in beneficiation of low and lean grade iron ores and other ores containing paramagnetic minerals such as ilmenite, wolframite etc. It is also useful for separation of feebly magnetic impurities from ores and concentrates.

Equipment Information

- Model & Make: Slon 500, M/s Outotec (USA) Inc, USA
- Year of Installation: 2014
- Resolution & Range:
- Ring diameter: 500 mm,
- Feed particle size: Below 1 mm
- Background field: 1 T
- Capacity: 30-125 kg/h

RI / RDI / TDI Measurement Instrument

Research Area: Agglomeration

RI/RDI/TDI Instrument is used for measurement of Reducibility Index (RI) Reduction Degradation Index (RDI) and Thermal Degradation Index (TDI) of iron ore, iron ore sinter and iron ore indurate pellets. It consist two furnace one reaction furnace and other gas generation furnace. Furnace temperature goes up to 1200'c maximum but normal working temperature 1100'c. Coal based CO, is generated in the gas generation furnace for reduction of the samples and proper ratio of CO, and N, maintained. N, gas is provided for creating neutral atmosphere through cylinder. RI, RDI and TDI are calculated as per standard practices.

Equipment Information

- Model & Make: M/s. Sandvik Asia Pvt. Ltd. Kolkata
- Year of Installation: 2014
- Sample: Iron ore, Iron ore Sinter, and Iron ore indurate pellets

Chamber Type Induration Furnace

Research Area: Agglomeration

Equipment Information

- Model & Make: Kanthal
- Year of Installation: 2012
- Application: To perform the pellet Induration test.
- Sample: Pellet size 9-16 mm

Chamber Type Induration simulates the actual conditions of pellet induration in a pelletizing plant, allowing for the evaluation of raw materials, optimization of process parameters, and optimization of pellet plant design and operations.

Coal Petrographic Optical Microscope

Research Area: Coal Characterization

It is the most advanced version of Polarized Light Petrological Microscope, manufactured by M/s Lieca, Germany. It has high-resolution optical devices operating under reflected as well as cross-polarized light modes. Through this, we can have images up to 500 magnification and measure the reflectance/rank of coal macerals as well as have modal counting of macerals and mineral matter on a visual basis.

It has a Petrog automatic point counting device for maceral analysis and QWIN software for image grabbing, enhancement, as well as storage at different scales. The coloured photographic camera attached to this microscope facilitates the grabbing of coloured images of organic and inorganic constituents in samples.

Equipment Information

- Model & Make: DM4500P & M/s Leica Mikrosystems Vertrieb GmbH, Germany
- Year of Installation: 2010
- Resolution & Range: It is equipped with high resolution lenses/objectives, photometers, fluorescence attachment, OWIN image analysis software & Petrog Softwares.
- Sample: Particle size ~ 1 mm size

Falcon Concentrator

Research Area: Chemical/Coal Analysis

Falcon Concentrator is a gravity-based centrifugal fluidized bed separator in which particles are separated by the application of centrifugal force based on their specific gravity. A centrifugal force of 200 g can be experienced by the particle inside the separating chamber just by controlling the speed of the rotor bowl. The radial hindered settling velocity of each particle depends on its density and size. Thus, heavier, coarser particles have the highest radial velocity, and lighter, smaller particles have the lowest radial velocity. The heavier particles form a bed of particles just adjacent to the wall of the bowl, and the lighter particle layer remains at the furthest site from the wall. A weak parallel force component helps in the migration of layers in an upward direction.

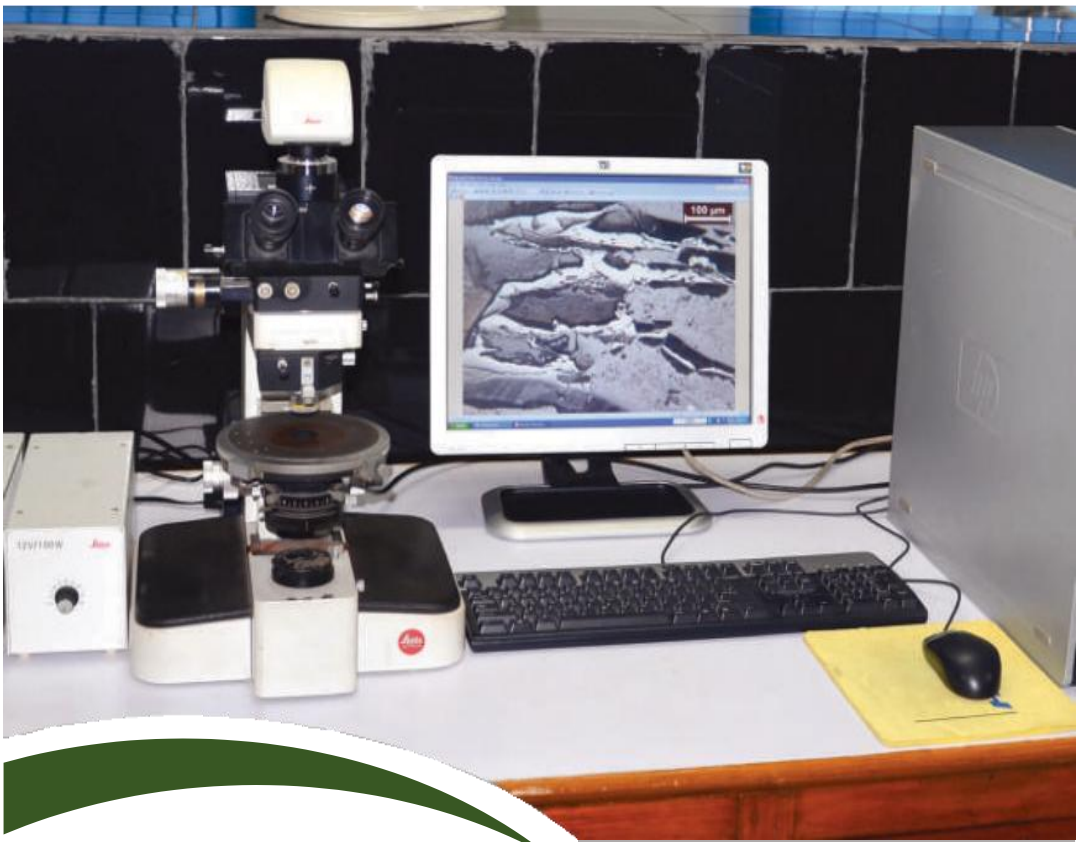
Equipment Information

- Model & Make: SB 40, M/s FALCON CONCENTRATORS INC, CANADA
- Year of Installation: 2007
- Resolution & Range:
  G force range: up to 200 g
- Sample: Solid ore sample

This is one of the enhanced gravity separators. By varying the rpm of rotor and water pressure the required grade and yield of the desired mineral is achieved. The equipment is particularly used in separation of precious metals such as gold ores and further recovery of mineral particle in fine size ranges. This equipment can also be used in the recovery affine grain mineral valuables lost in the tailings.

Optical Petrological Microscope

Research Area: Mineral Characterization



Optical petrological microscope is a versatile equipment for mineral and phase identification. It has both reflected light (RL) and transmitted light (TL) facilities to study polished mounts and thin section slides of minerals respectively. Monochromatic plane polarised light is used and with the aid of nicols (polariser and analyser) minerals are identified with certainty. The textures, structures and other characteristic optical properties of minerals are documented through the attached digital photographic system.

Equipment Information

- Model & Make: Leitz Orthoplan; M/s Leica Mikrosystems Vertrieb GmbH,Germany
- Year of Installation: 2004
- Resolution & Range: Magnification: 50 to 500 times; Objective lenses (dry) used are 5X, 10X, 20X and 50X. It is equipped with high resolution digital camera (Leica DFC 420 C) for microphotography, OWIN image analysis, and LAS software.
- Sample: Polished mounts and thin section slides

Dual System of Plastometer and Dilatometer

Research Area: Coal Characterization

The equipment measures the plastic and dilatation properties of coal on heating as per ASTM protocol. It also measures softening temperature, resolidification temperature, and temperature of maximum fluidity. The data is useful in engineering applications of coal in carbonization, gasification, liquefaction, and combustion.

Equipment Information

- Model & Make: Plastometer model - PL2000, Dilatometer model - D14000, M/s R.B. Automazione S.R.L.
- Year of Installation: 2013
- Applications: Characterization of plasticity and dilatation properties of coal
- Resolution Range: Range of Plastometer 0.2-10000 DDPM,
- Sample: Coal of size -40 mesh to +70 mesh for plastometer, and -72 mesh for Dilatometer

CRI-CSR Equipment

Research Area: Coke Characterization

The equipment measures (i) Coke Reactivity Index (CRI) and (ii) Coke Strength after Reaction (CSR), indicative of the performance of coke in the Blast furnace. 200 g of sample is heated with CO_2 at 1100°C in a retort, followed by tumbling. The percentage of mass loss gives CRI, and the percentage of + 10 mm particles retained by tumbling gives CSR as per ASTM protocol. The data is useful in determining coal quality for blast furnace applications.

Equipment Information

- Model & Make: Sandvik Semiautomatic CRI-CSR, Sandvik Asia
- Year of Installation: 2013
- Applications: Coke characterization
- Sample: Coke of size -21 to + 19 mm or as per IS and ASTM norms

Electromechanical Compression Testing Machine

Research Area: Minerals/Rocks and Pellet Characterization

Electromechanical Compression Testing Machine is purchased from M/s. Zwick Asia Pte Ltd, German, Model Z020 TN Allround-Line Table Top Machine. Principally compressive force is developed by mechanically and speed limitation of 600 mm/min and closing specimen grips is a safety measure for automatically operated specimen grips. This speed can be reduced. There are two load cells such as 200N and 20kN. The minimum force is 80 N and maximum 20kN. It is software based / manual based operation system. Machine is mainly for measurement of breaking load of pellet, rock and other materials.

Equipment Information

- Model & Make: Model: Z020 TN Allround-Line Table Top Machine, Make : M/s. Zwick Roell Pte Ltd, German
- Year of Installation: 2014
- Sample: Rock: 2.5 x 2.5 x 2.5 cm, Pellets: 10-15 mm Dia.

Blaine Number Measurement Apparatus (Electronic Air Permeability Tester)

Research Area: Powder Characterization

Electronic Air Permeability Testes is used for measuring surface area (Blaine Number) of powder materials using without using mercury. Purchase from German and installed in August 2012. The range of Blaine number is 1000 - 4000 sq. cm. The stander sample is quartz sand having Blaine number 2800 and 3990 sq. cm. The sample power is compressed by the punch in the gauge head to a definite volume. After installation of the filled gauge head and input of the test -specification sample data in the controller display, the test is carried out and the data are evaluated entirely automatically. The Blain value is calculated as the average of the individual values from the gauge head and is oriented in accordance to a standard EN 196.

Equipment Information

- Model & Make: 6565, Version: 12/2011, M/s. Toni Technik Pte Ltd, German
- Year of Installation: 2012
- Sample: Powder

Materials Engineering

MTE

CSIR-NML Jamshedpur

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Laboratory Scale Inert Gas Atomizer

Research Area: Powder Making / Additive Manufacturing

CSIR-NML, has taken a lead role to realize “Self-reliant India”, and setup a state-of-the-art "Laboratory scale Inert Gas Atomizer (IGA)” facility in India. This unique facility is aimed at leveraging:

- Indigenous development of metal/alloy powders suitable for Additive Manufacturing (AM) & allied applications
- To design & develop new alloys, which in-turn results in improved properties for AM components
- This unique facility will be extended to industries / academic institutions, for collaborative efforts towards development of indigenous/ new materials for AM

Equipment Information

- Model & Make: AU1000, Bluepower, Germany
- Year of Installation: 2023
- Application: To produce metal/alloy powders
- Max. temperature: 1750ºC
- Sample: Metal/alloy chunks up to 5 kg per melt (1 inch max in any dimension)

Resistance Heating-based Melting Furnace

Research Area: Melting and Casting

The Aluminum (Al) and Aluminum-Alloys Melting Furnace of 10 Kg capacity is a specialized laboratory apparatus designed for controlled melting and casting of aluminum and its alloys in experimental research. This furnace provides precise temperature regulation, uniform heat distribution, and a stable melting environment, ensuring reproducible results for metallurgical studies.

Equipment Information

- Model & Make: Melting Furnace, Jay Crucible
- Year of Installation: 2023
- Application: Melting of Al alloys up to about 900°C

GLEEBLE 3800 ™

Research Area: Heat Treatment and Processing

Gleeble 3800™ is an advanced experimental system designed for process simulation, material testing and analyzing the thermal behavior of material under different process condition. It can simulate wide range of processes like welding, casting, forming (Hot rolling and extrusion), Heat treatment (Strip Annealing) etc.

The system provides precise control over temperature, strain and strain rate. The system collects real time data such as force, temperature and displacement. Overall, it is one of the crucial experimental component for advance metal/alloy research, providing valuable data for improving processes and developing new material.

Equipment Information

- Model & Make: Gleeble 3800™ Make - DSI USA
- Year of Installation: 2013
- Application: Thermo–mechanical simulation and Material testing
- Heating Rate: 10000° C/s (Max.)
- Force: 20 T (Compression) & 10 T (Tension)
- Stroke: 100 mm (Max.)
- Stroke rate: 2000 mm/s (Max.)
- Sample: As per the Test

Resistance Furnace

Research Area: Heat Treatment

Equipment Information

- Model & Make: JC furnace
- Year of Installation: 2018
- Application: sintering, annealing, forging, and other high-temperature processes.
- Resolution and Range: 200°C to 1200°C
- Sample: All Metallic Materials

Our high-performance resistance heating furnaces have been designed to function at temperatures reaching 1100°C and 1200°C, ensuring accurate and effective heating for heat treatment in research and development as well as a range of industrial applications. Highlighted features of the furnace include High-Temperature Capability, Efficient Heating Elements, a User-Friendly Control System, and its suitability for a range of applications, making it perfect for sintering, annealing, forging, and other high-temperature processes.

Large-scale Muffle and Salt Bath Furnace Setup

Research Area: Heat Treatment

This customized muffle and salt bath furnace setup, equipped with a lifting mechanism, is designed for heat treatment of large-size samples. The muffle furnace can heat samples up to 1100°C, with a 400L × 300W × 450H (mm) heating zone. The salt bath furnace is suitable for interrupted quenching, operating within a temperature range of 200-600°C. It has dimensions of 550L × 450W × 750H (mm) and a salt capacity of about 100 liters.

Equipment Information

- Model & Make: Ants Innovations Pvt. Ltd.
- Year of Installation: 2025
- Application: Heating, Holding, and quenching
- Sample: Solids

Salt Bath Furnace

Research Area: Heat Treatment

This salt bath furnace offers improved heat transfer to the sample during heating, holding, and cooling cycles, ensuring excellent temperature uniformity across the entire cross-section.

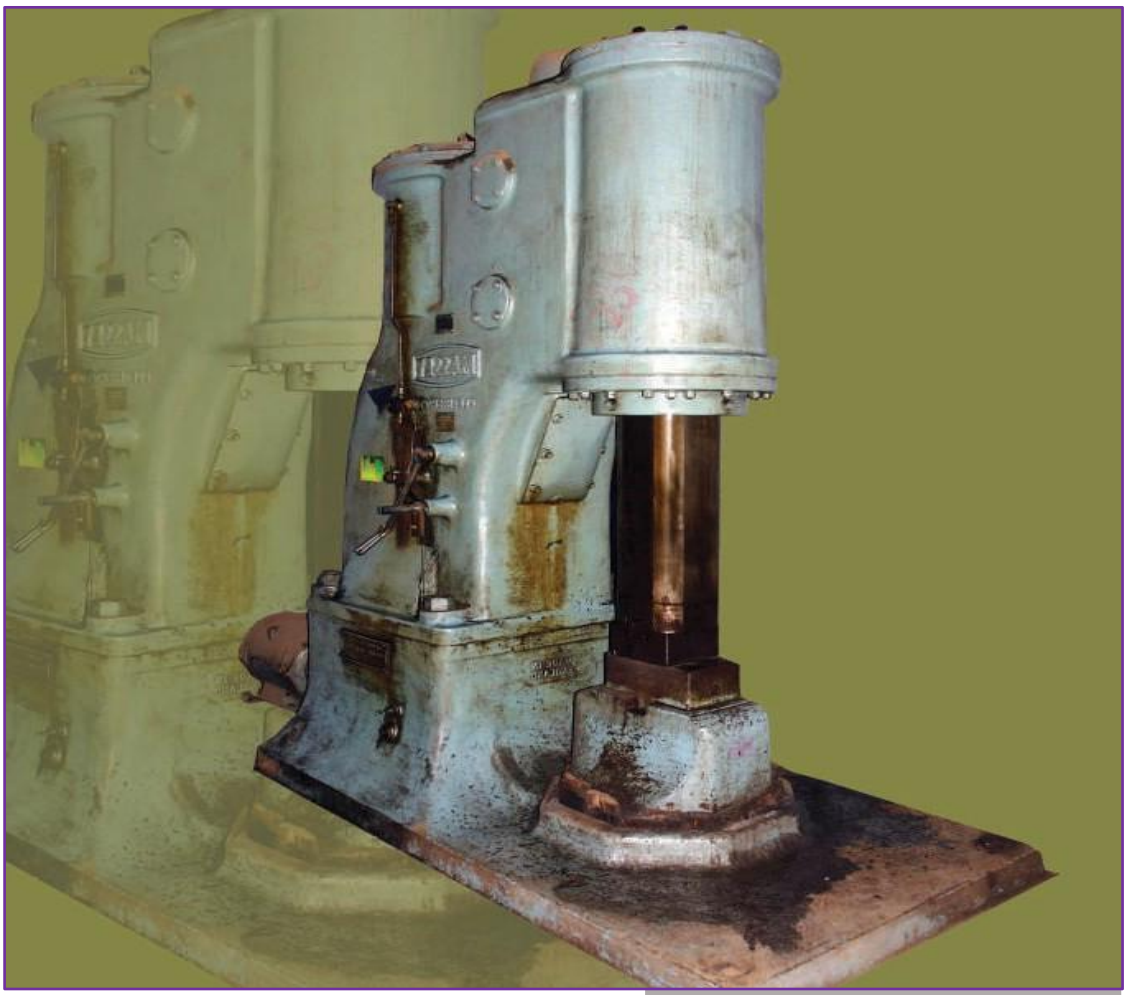
The furnace operates within a temperature range of 200-600°C. The cylindrical molten salt pot has a diameter of 15 cm and a height of 25 cm.

Equipment Information

- Model & Make: LTI-S1100, Thermindia (2 Nos)
- Year of Installation: 2021, 2023
- Application: Heating, Holding and quenching
- Sample: Solids

Forging Hammer

Research Area: Metal Forming



Three Pneumatic power hammers of 1 ton, 0.5 ton and 0.1 ton capacities have been used for open die forging.

Equipment Information

- Model & Make: Pneumatic Power Hammers, B&S Massy Ltd., England.
- Year of Installation: 1960
- Applications: Open die forging
- Resolution & Range: 10 CWT, hammer speed 110, Flywheel speed 544, HP 60 (max)

Rolling Mill

Research Area: Metal Forming

Two high and four high rolling Mill: A two high is for hot rolling and four high rolling mill for cold rolling for ferrous and non ferrous metals, was built by Newfield Engineers Pvt. Ltd. The mill stand has a pair of working roll diameter of 300 mm and roll made of Chilled Cast Iron/Forged with stand hot or cold rolling Mill. Maximum Roll Gap is 70 mm.

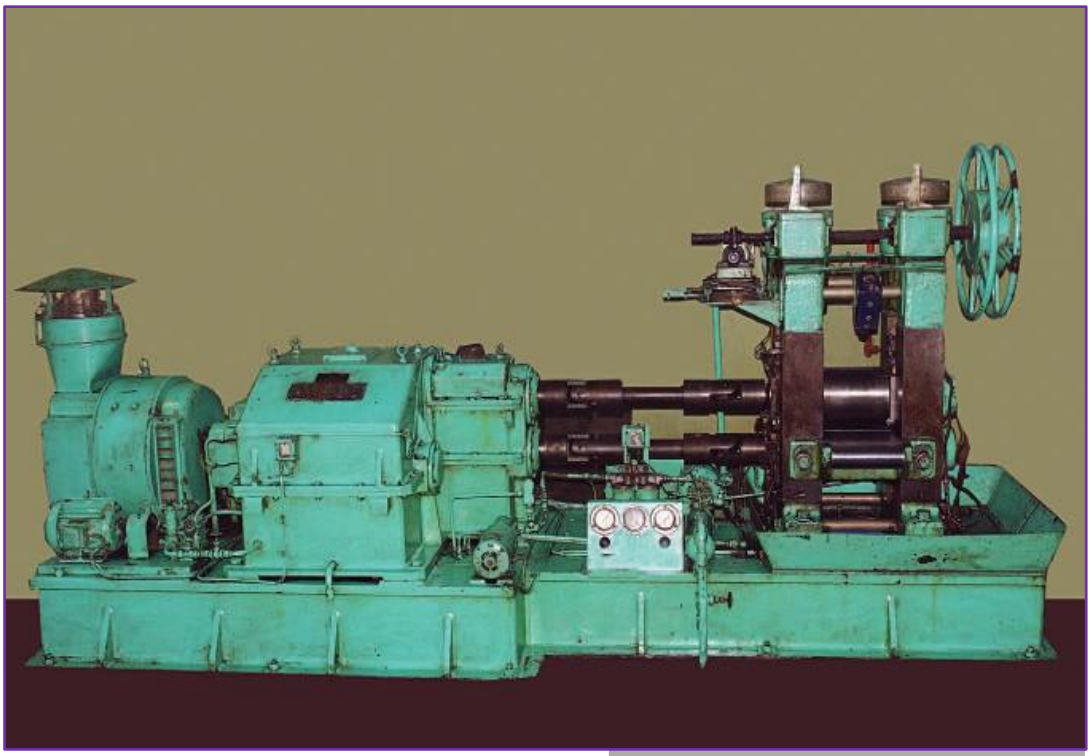
Two and four high rolling mills: Four high rolling mill have been used for cold rolling ferrous and non-ferrous metals. The size of the working rolls is a pair of 100 mm, and the size of the backup roll diameter is 300 mm. The capacity of the machine is 150 tons. The maximum roll gap for cold rolling is 8 mm.

Equipment Information

- Model & Make: 2 high and 4 high rolling mill, Newfield Engineers Pvt. Ltd.
- Year of installation: 2023

Rolling Mill

Research Area: Metal Forming



Two high rolling mill: A two high rolling mill for hot and cold rolling for ferrous and non-ferrous metals was built by Hydro-press Inc. The mill stand shown has a pair of 6in. diameter x 10 in. face rolls made of special harden forged steel to with stand hot or cold rolling. Maxim roll gap is 50 mm.

Two as well as four high rolling mill: A two as well as four high rolling mill have been used for hot and cold rolling of ferrous and nonferrous metals. The size of the rolls is a pair of 3.5 in. & 18 in. diameter X 20 in. face rolls. The capacity of the machine is 100 tons. Maxim roll gap is 50 mm.

Equipment Information

- Model & Make: 2 high rolling mill, Hydropress, INC, New York 22, and 2/ 4 high rolling mill, Albert Mann's Engg. Co. Ltd. Basildon Industrial Estate-Essex, England.
- Year of Installation: 1948
- Applications: Rolling ferrous as well as non ferrous materials
- Resolution & Range: 2 High Rolling Mill (6" diameter & 8" face rolls), and 2/ 4 High rolling mill (2.5/ 10" dimeters & 10"/ 10" face rolls)

Wire Drawing Machine

Research Area: Metal Forming

Bench-type wire drawing machines is used for drawing ferrous as well as nonferrous materials. In the present setup, wires up to 0.3 mm in diameter can be drawn.

Equipment Information

- Model & Make: FN2AP & FN3B, Sir James Farmer Norton & Co. Ltd. Manchester, England
- Year of Installation: 1960 Applications: Wire Drawing
- Resolution & Range: up to 0.315 mm or 30 SWG

Metallographic Sample Preparation

Research Area: Microstructural Characterization

This metallographic sample preparation facility is equipped with various tools, including a belt grinder, mounting press, emery papers and cloths, etching reagents, electropolishing setup, and an ultrasonic cleaner, all designed to prepare a smooth, well-finished surface for microstructural examination.

Ion Beam Milling

Research Area: TEM Sample Preparation

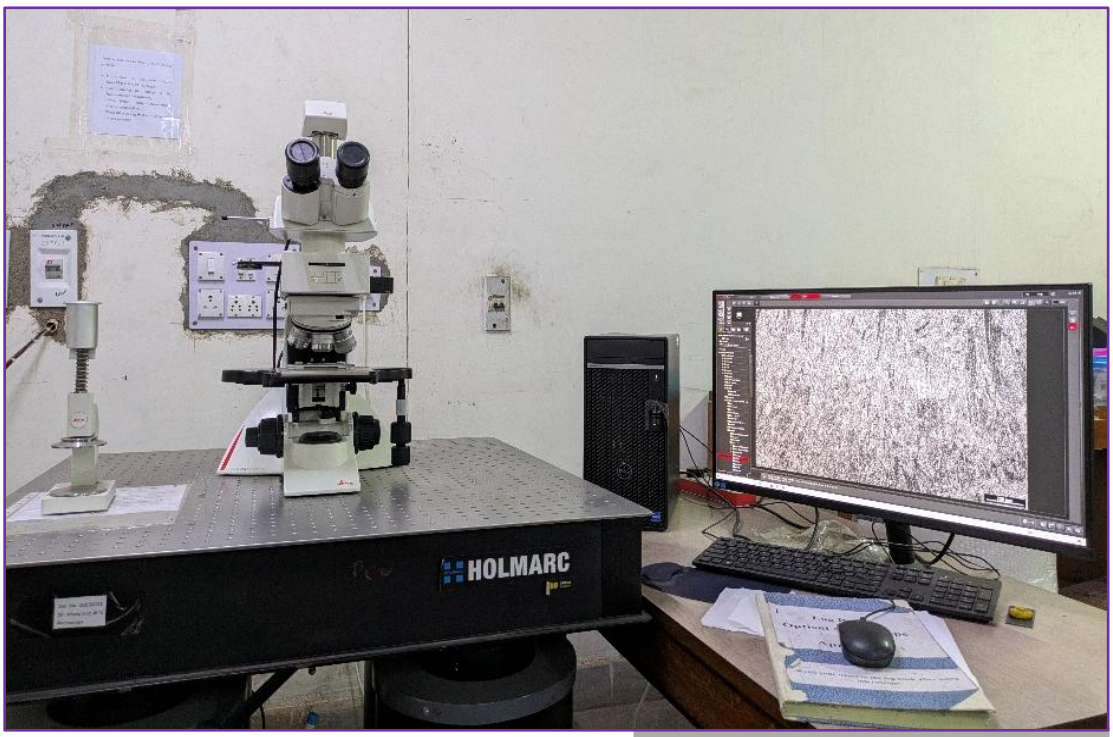
Equipment Information

- Model & Make: Gatan PIPS II
- Year of Installation: 2019
- Application: Sample preparation for TEM
- Sample: Metallic samples
- Feature: Ar ions are produced by two ion guns, each with independently adjustable gas flow control
- Ion beam energy: 100 eV – 8 KeV
- Milling angle: ± 10^{o}
- Cold stage: Cryo milling can be performed (up to -80°C)
- In-situ viewing: Available
- Auto-terminator: Available

Ion beam polishing is a precise technique commonly used in the preparation of thin samples for Transmission Electron Microscopy (TEM). The process involves bombarding the surface of a sample with beam of ions, typically Ar, to remove material layer by layer, thus achieving the ultra-thin specimens required for TEM analysis. Prior to ion beam polishing the metallic sample is mechanical ground to a thickness ~ 60 µm using emery papers, followed by dimple grinding to further thin down the sample to achieve a thickness in the range of 10-20 µm in the dimpled region. The prepared sample is then loaded in the Ion Beam Milling Equipment for final thinning to a thickness level ~40-100 nm to make the specimen electron transparent, facilitating observation in a Transmission Electron Microscope.

Upright Optical Metallurgical Microscope

Research Area: Microstructural Characterization



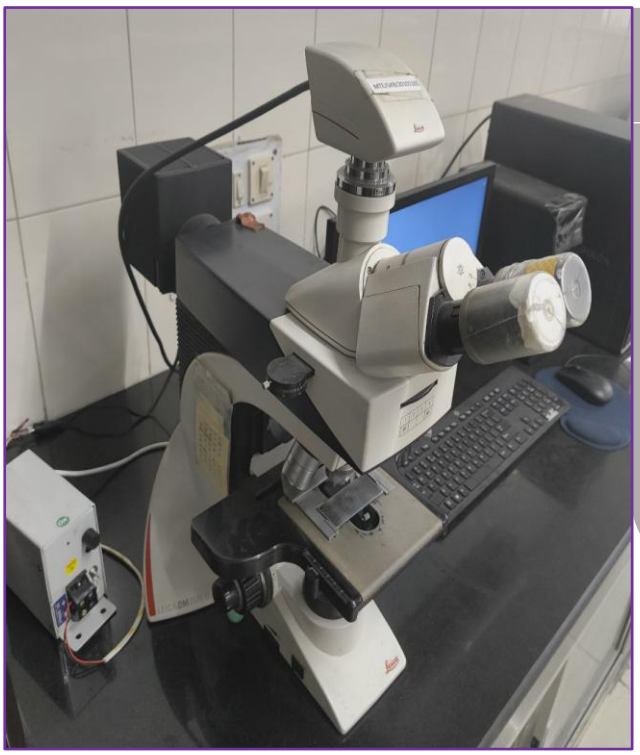
Optical metallurgical microscope is a versatile equipment that contains high-quality optics with state-of-the-art universal white light LED illumination. It has contrast techniques like bright field, dark field, and polarization features. It is equipped with image analysis software with facilities for image calibration as per different objective magnifications, micron bar, image acquisition, imaging parameter recall, HDR acquisition, and measurements such as length, area, angle, and annotation. It is an ideal inspection tool for all kind of routine inspection tasks in metallography, materials quality control, and research.

Equipment Information

- Model & Make: DM2700M, M/s Leica Microsystem
- Year of Installation: 2023
- Resolution and Range: Magnification: 50 to 1000 times. Objective lenses (dry) 5x, 10x, 20x, 50x and 100x. It is equipped with high resolution digital camera for microphotography.
- Applications: Microstructural characterization
- Sample: Polished mounts ferrous and non-ferrous metals

Optical Microscope

Research Area: Microstructural Characterization



Equipment Information

- Model & Make: DM2500 M, LEICA
- Year of Installation: 2010
- Application: Imaging, Inclusion rating, Grain size & phase percentage measurement
- Sample: Solid

This equipment utilizes visible light as its source and lenses to capture images at different magnifications (5x, 10x, 20x, 50x, and 100x). It is also equipped with software for inclusions rating, as well as measuring grain size and phase percentage, in accordance with relevant standards.

Scanning Electron Microscope

Research Area: Microstructural Characterization

Equipment Information

- Model & Make: HITACHI SU700 FESEM with EDAX EDS-EBSD
- Year of Installation: 2020
- Application: Imaging, Microscopy
- Resolution: 0.8 nm at 15 kV.
- Sample: Metals and Materials

The HITACHI SU7000 is an ultra-high-resolution Field Emission Scanning Electron Microscope (FESEM) providing unparalleled analytical capabilities for the characterization of metals, alloys and materials. It is equipped with state of the art in-lens (upper, middle and lower) detectors, in-chamber secondary electron (SE) detector, in-chamber Back Scattered Electron (BSE), EDAX Octane - Energy Dispersive Spectrometer (EDS) and Velocity – Electron Back Scattered Diffraction (EBSD) detector. It also has provision for transmission EBSD (t-EBSD) for carrying out EBSD studies on TEM samples. Its ability to combine high-resolution imaging with sophisticated analytical techniques makes it indispensable for a diverse range of research and industrial applications, including materials science, metallurgy, and nanotechnology.

X-Ray Diffractometer

Research Area: Materials Characterization

The high-resolution and high-temperature X-ray diffractometer equipped with reflectometry at NML was installed in the year 2008. The main important feature of the system is its high-resolution capabilities. Apart from the routine quality & quantitative phase analysis, the available software, TOPAS, can be used to determine micro-strain and crystallite size. The reflectometry attachment, along with the LEPTOS software, can be used for the characterization of thin films. The high temperature camera (up to 1600 degree C) with facilities to operate under controlled atmosphere and vacuum is used for high temperature phase transformation studies. The Euclerian Cradle available with the diffractometer gives it additional capability for crystallographic texture measurements.

Equipment Information

- Model & Make: D8 Discover, Bruker AXS GmbH, Germany
- Year of Installation: 2008
- Applications: To characterize minerals, metals, and alloys
- Resolution & Range: 2 theta measuring range 0 to +1600, angular reproducibility +/- 0.0001 deg or better, minimum step size 0.0001 deg.
- Output - Plot
- Sample: Solid or powder

Electron Probe Micro Analyzer

Research Area: Microstructural Characterization

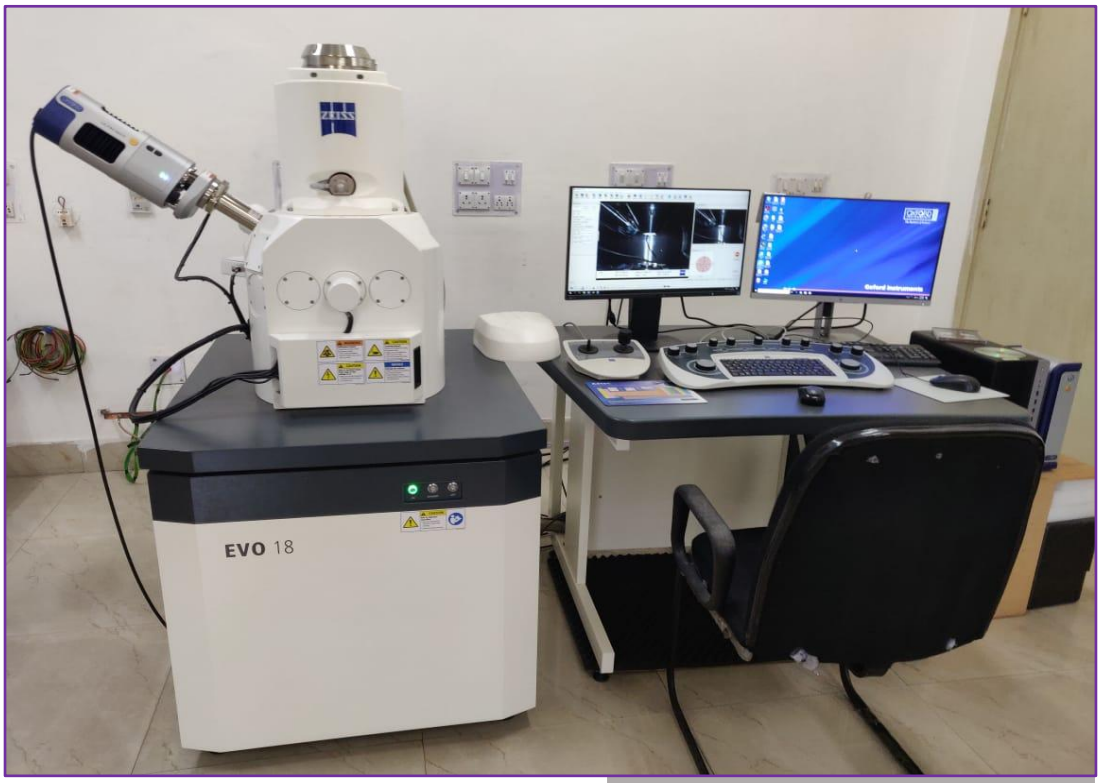
Electron Probe Micro Analyzer (EPMA) is a high-resolution elemental analysis instrument combined with wavelength dispersive X-ray spectrometers (WDS) and energy dispersive (EDS) analyzer. It can analyze elements both qualitatively and quantitatively. Depending on the requirement Wand La86 filament can be used. Point, line, and area analyses are possible, also, elemental distribution can be identified by map analysis. The minimum probe size is 0.5 microns (region of analysis).

Equipment Information

- Model & Make: JXA-8230, JEOL, Japan
- Year of Installation: 2010
- Applications: Micro elemental analysis of interface, inclusions, coating, ores and minerals, metal-slags, weld overlay, cladding, etc.
- Resolution & Range :
- Operating Voltage: up to 30 kV
- Probe Current Range: 10^{-12} to 10^{-5} A
- Image Resolution: SEI- 6 nm (W); 5 nm (LaB_6) at W.D. 11 mm, 30 kV
- Energy Resolution: WDS - 8 eV (for Fe-K_α); EDS -133 eV (for Fe-K_α)
- Detectable element: WDS & EDS - B to U
- Detection Limit: WDS - a range of ppm; EDS - ~ 1000 ppm
- No. of Channels/Spectrometer: WDS - 2 (Crystals: LIF, PETJ, LDE, TAP); EDS-1
- Sample Sizes: < 36 mm dia. X 20 mm H X 4 pcs & < 25.5 mm dia X 20 mm H X 9 pcs
- Sample: Materials should not have volatile substances. Metallographically polished to optical flatness for WDS analysis.

SEM-EDS with Automated Inclusion Analyzer

Research Area: Microstructural Characterization



The facility at CSIR-NML is capable of automated imaging and large area composition mapping at a faster acquisition speed. It is a useful tool for quantification of microstructural elements and their composition. Aztec Inclusion Analyzer is custom-designed for acquiring chemical information and identifying inclusions and is capable of classifying as per International standards. aids in the design and control of clean steel production

Equipment Information

- Model & Make: EVO18-Zeiss with Aztec Inclusion Analyzer
- Year of Installation: 2021
- Application: ASTM E2142, SEI and BSE Imaging, Feature Analysis, EDS

Transmission Electron Microscope

Research Area: Microstructural Characterization

The JEOL JEM 2200FS is an advanced and unique transmission electron microscope (TEM) that covers a range of imaging modes and spectroscopic applications. The state-of-the-art analytical equipment, equipped with a Schottky FEG that can operate in ranges of 80-200 kV in steps. This microscope was installed in CSIR NML in the year 2013 and became fully operational from early 2014. It is one of the new generation TEMs that need no dark room. The main Frame of the TEM is mounted on a passive type air mount and supported with oil-free vacuum pumping systems. It produces rotation-free images, which makes it easy to compare TEM images and diffraction patterns. The instrument has an in-column Q-filter, which is optimally configured for analytical functions and has excellent energy stability that makes it suitable for energy-filtered studies such as Energy Electron loss Spectroscopy (EELS). The EELS study provides spectroscopic and elemental imaging for different phase in nano range and composition including carbon with more accuracy. The energy filter provides zero-loss filtered images and diffraction patterns with high contrast by removing contribution of inelastic scattering. The microscope is also equipped with Scanning transmission (STEM) imaging mode with minimum probe size of 0.2 nm that allows to study nano-precipitates and Z-contrast imaging effectively.

STEM mode benefits with HAADF, BF, and DF detectors. The STEM-EDS acquisition mode adds great advantages for point and elemental mapping for compositional analysis of different phases. The EDS is equipped with an SDD detector having an 80 mm^2 aperture, where a small amount of concentration can be analyzed. TEM images and diffraction patterns can be acquired digitally on a Gatan 2k x 2k CCD camera. The TEM has other facilities like HR-TEM, Nano Beam and convergent Beam Electron Diffraction (CBED).

Equipment Information

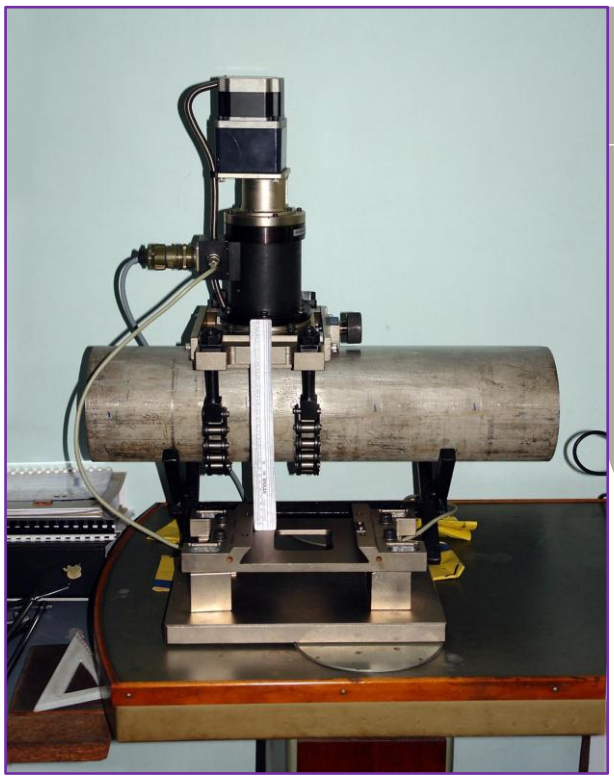
- For structural characterization and crystallographic study of metals, ceramics, alloys, amorphous materials, non-magnetic powder samples, thin films, etc. (no polymer sample/ carbonaceous organic material will be entertained). Available modes are TEM BF, SADP, DF, EDS, EELS, STEM, NBD & CBED

Range and resolution

Point-image Resolution	0.23 nm at 200 kV
Lattice resolution	0.1 nm at 200 kV
Accelerating Voltage	80 to 200 kV in steps
Magnification	X (100-1,500,000)
Specimen tilt	a = ±30°

Portable Automated Ball Indentation (PABI)

Research Area: Materials Evaluation



Equipment Information

- Model & Make: India
- Year of Installation: 2010
- Application: Evaluation of Mechanical Properties
- Sample: Flat specimens more than 2 mm thick

PABI, a portable automated ball indentation (PABI) system, has been designed and developed by NML, Jamshedpur, in collaboration with BARC, Mumbai. PABI set up is the most desired equipment to meet the requirements of in-situ measurement. It measures tensile properties, Hardness, and fracture toughness, etc., by using a curve.

Brinell Hardness Tester

Research Area: Hardness Evaluation

This equipment is capable of automatically measuring the hardness of various solid materials with hardness up to 600 HBW. Users can select from different combinations of tungsten carbide indenter ball diameters (2.5 mm, 5 mm, and 10 mm) and test forces/loads (ranging from 62.5 to 3000 kgf) based on their specific requirements.

Equipment Information

- Model & Make: BHTA-3000MT, Banbros
- Year of Installation: 2022
- Application: Hardness Measurement
- Sample: Solid

Dry Sand Rubber Wheel (DSRW) Abrasion Test Rig

Research Area: Wear Resistance Evaluation

The Dry Abrasion Testing (TR50) Machine is a precision instrument designed to evaluate the wear resistance of materials under dry abrasive conditions. It operates by subjecting test samples to controlled abrasive forces, simulating real-world wear scenarios.

Equipment Information

- Model & Make: TR-50, Ducom
- Year of Installation: 2003
- Application: Wear loss Measurement
- Sample: Solid

Air Jet Erosion Tester

Research Area: Wear Resistance Evaluation

Equipment Information

- Model and make: TR 471-M3, made: Ducom, Bangalore India
- Applications: Evaluation of Erosion resistance of materials
- Process Parameters: Angle of incidence: 15, 30, 45, 60 and 75°, Erodent: Al,O3 and SiC, Erodent-size: 100-250 µm, Velocity 40 - 150 m/sec, Temperature: RT to 600°C, Nozzle Size: diameter 1.5, 3, 4.5, 6 and 8 mm, Erodent discharge: 0.5 to 5 gm/min, Test Duration: up to 4 hrs
- Sample: 25 X 25 X 3 mm

The TR 471-M3 Air jet Erosion tester may be used for performing erosion test by solid particle impingement using Air jets. The method involves using a small nozzle delivering a stream of gas containing abrasive particles that impact the surface of a test specimen. Test parameters such as particle velocity, erodent feed rate, temperature, test duration, and orientation of specimens can be varied.

The air jet erosion testing unit is used for determining the erosion resistance of materials. This practice in any overall measurement program to assess the erosion behaviour of materials will depend on many factors concerning the conditions of service applications. The users of this practice should determine the degree of correlation of the results obtained with those from field performance or results using other test systems and methods.

Ultrasonic Cavitation Erosion Testing Machine

Research Area: Wear Resistance Evaluation

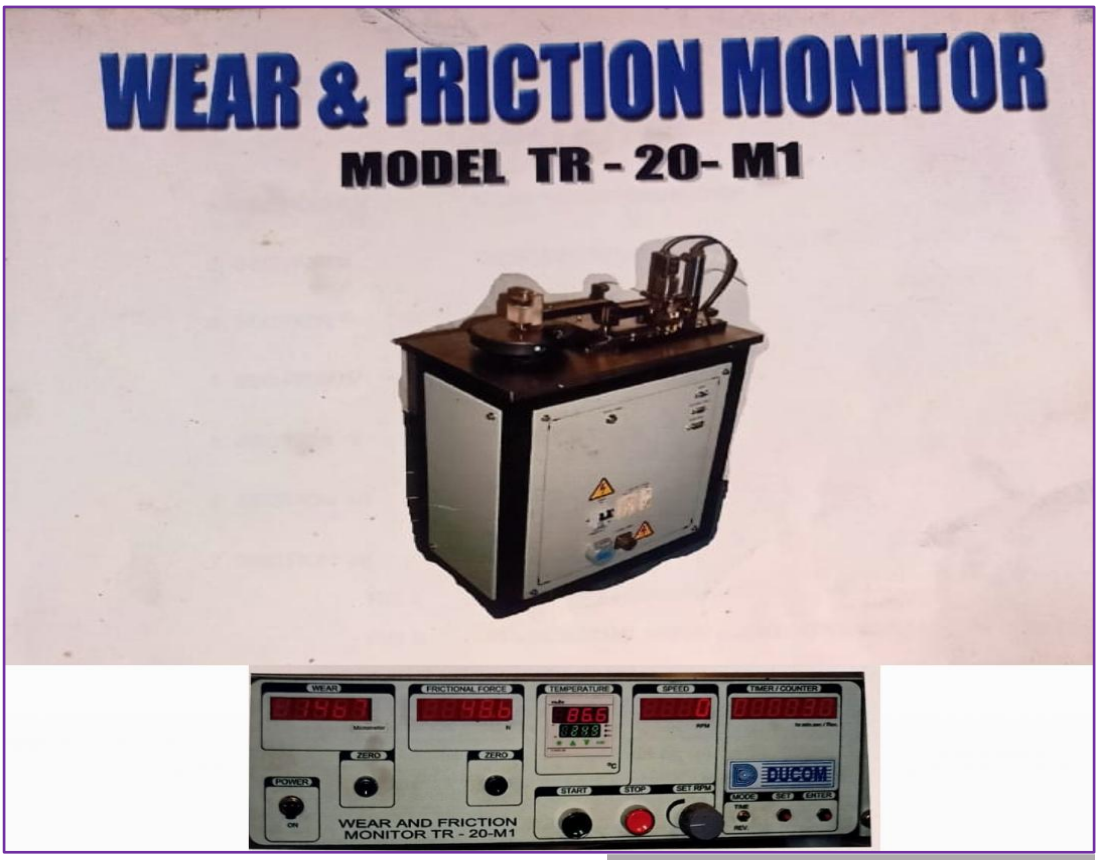
Equipment Information

- Model & Make: UPS: 2000 & M/s Roop Telsonic Ultrasonix Ltd. Mumbai
- Year of Installation: 2009
- Resolution & Range:
- Output Frequency: 20 KHZ; Output Power: 1.0 KW;
- Mode of operation : (a) Constant Amplitude mode (50 µm) (b) Constant Power mode; Ultrasonic Out: Continuous Mode/Pulsed Mode;
- Sample: Any material that can be made to the standard samples.

Ultrasonic Cavitation Erosion Testing Machine is used to carry out cavitation erosion resistance evaluation of a material as per ASTM G 32 procedure. This apparatus is also known as Vibratory Apparatus for cavitation erosion. Ultrasonic wave is used to induce cavitation i.e. generation and collapse of cavitation bubbles in the liquid. The erosion resistance of any material is evaluated in terms of weight loss or mean depth of erosion (MDE) per unit time.

Pin on Disk (POD) Wear & Friction Monitor

Research Area: Friction & Wear Resistance Evaluation



The wear and friction monitor TR-20-MI is a pin on disc type wear and friction monitor with facilities to monitor wear & friction under dry, different temperature, lubrication and desired environmental condition. This is a sturdy versatile machine which facilitates study of friction and wear characteristics in sliding contacts under desired conditions. Sliding occurs between the stationary pin and a rotating disc. Normal load, rotational speed and wear track diameter can be varied to suit the test conditions. Tangential frictional force and wear are monitored with electronic sensors and recorded.

Equipment Information

- Model & Make:TR-20-M1, Ducom
- Year of Installation: 2003

Liquid Nitrogen Plant

Research Area: Liquid Nitrogen Production

A liquid nitrogen plant produces liquid nitrogen at a temperature of - 40°C. This liquid nitrogen is used for sub-zero temperature testing and sophisticated equipment cooling, etc.

Equipment Information

- Model & Make: Stir Lin-1 Netherland
- Year of Installation: 2010
- Application: Sub-zero Temperature
- Sample: Liquid nitrogen at -40^{o}C

High Performance Computing Cluster

Research Area: Atomistic Simulation & Artificial Intelligence

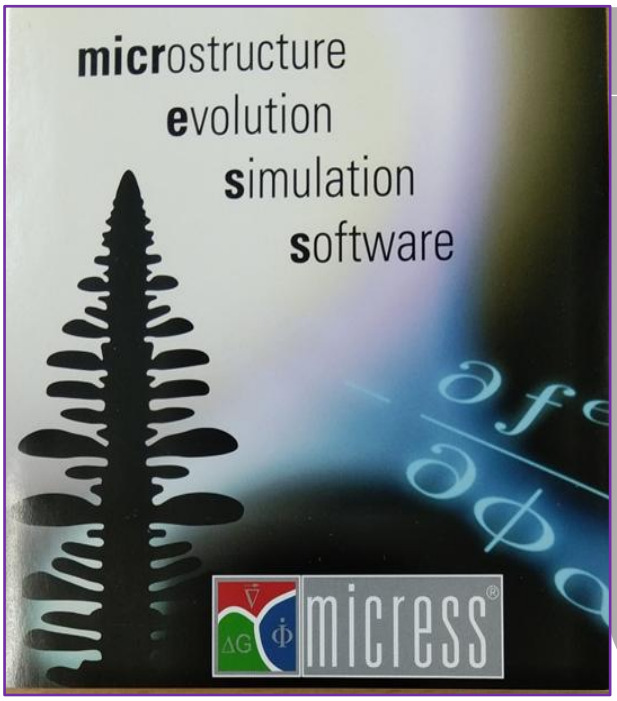
High-Performance Computing (HPC) clusters play a crucial role in atomistic simulations and AI/ML applications by providing the massive computational power required for handling complex and large-scale problems. In atomistic simulations, HPC clusters enable efficient execution of simulations, allowing researchers to model the behavior of metals, alloys, polymers, and nanocomposites at the atomic scale with high accuracy. Similarly, in AI and ML applications, HPC clusters facilitate the training of deep learning models and regression-based algorithms for predicting material properties, optimizing reaction pathways, and accelerating materials discovery. By leveraging HPC clusters, researchers can significantly improve the efficiency, scalability, and reliability of computational simulations and AI-driven material design.

Equipment Information

- Model & Make: Dell Power Edge
- Year of Installation: 2019
- Application: Atomistic simulation and Artificial Intelligent Calculations

MICRESS (Academic Version)

Research Area: Simulation of Microstructure Evolution



Equipment Information

- Model & Make: MICRESS-7.003 (Academic version)
- Year of Installation: 2019
- Application: Prediction of microstructure evolution.
- Resolution and Range: Mesoscopic model
- Sample: Experimental microstructure, composition, heating-cooling curve.

The MICRESS software is based on the multiphase field concept and enables simulation of microstructure evolution in multi-component alloy system. It enables prediction of microstructure evolution during phase transformation in metallurgical systems.

Universal Sheet Metal Testing Machine

Research Area: Formability Evaluation

This testing machine can be used to perform effortlessly, quickly, and accurately all important and known formability tests for ferrous and non-ferrous sheet metal. The testing machine is driven electro-hydraulically. The test sequence is controlled automatically or manually, as desired. A programmable logic controller is used to control the functions of the machine. The testing machine is equipped with digital displays for indicating the sheet holder force, the drawing force as well as the drawing punch stroke.
Relevant test attributes are: Determination of the Forming Limit Curves (FLC, ISO 12004), Hole Expansion Ratio/ Bore Expanding Test (ISO 16630), Erichsen Cupping Test, Deep Drawing Cup Test

Equipment Information

- Model & Make: 142-40, M/s Erichsen GmbH & Co. KG, Germany
- Year of Installation: 2018
- Applications: To perform formability of sheet metals
- Sample: Ferrous and non-ferrous thin sheets

Instrumented Charpy Machine

Research Area: Charpy Impact Toughness Evaluation

Conventional impact test machines are used for estimating the notch toughness of materials, which in turn is used as the material screening criteria in manufacturing industries. The instrumented impact test machines are a special variety, in which, apart from the conventional notch toughness, the system would capture the load and displacement data within few milliseconds of the hammer contact with the specimen. This data can be used to determine the dynamic fracture resistance of the material such as K,0 and the ductile to brittle transition temperature (DBTT) of metals and alloys. The system is equipped with a temperature bath in the range of + 150°C to - 80°C. Dynamic fracture characterization of materials in a wide spectrum of temperature is therefore possible. The system is calibrated with NIST (National Institute of Standards and Testing-USA) standard reference specimens.

Equipment Information

- Model & Make: Zwick-Roell
- Year of Installation: 2009

  Applications: Impact Testing, DBTT, KID
- Resolution & Range: 450 J
- Sample: Charpy V-notch

Creep Testing Facilities (73 Test Points)

Research Area: Mechanical Properties Evaluation

Creep is the time dependent deformation process taking place at temperatures *above* 40% of melting point of the alloy. All alloys intended to be used for high temperature structural parts need to be evaluated for creep strength properties. Components operating at the creep regime need to be designed to last the design life. Creep and stress rupture testing is used to evaluate the life of the alloy material at the given stress and temperature range through a master life curve generated from a series creep/ stress rupture tests. Creep/stress rupture testing usually done under constant load and temperature conditions. Creep induced displacement and rupture time are measured.

Equipment Information

- Sample: Cylindrical (M8, M10, 1 /2"BSF, 1 /2"-UNC, 1 /2"-UNF, 5/8"BSW, 5/8"UNF thread gripping), Flat (8 mm thick max.), Curved (8 mm thick including curvature)

Creep-Fatigue Test Machine

Research Area: Mechanical Properties Evaluation

Equipment Information

- Model & Make: Instron 8861
- Year of Installation: 2011
- Applications: Creep-Fatigue Interaction
- Resolution & Range: 32 kN
- Sample: Round cylindrical specimen

NML has 3 numbers of dedicated electro-mechanical screw driven system (3.2 T capacity) with furnace (1100°C) exclusively for studying the creep-fatigue interaction of materials. The function generator of the system can provide various waveforms with long hold time (100 hrs) at either or both the peaks. Side entry type high temperature extensometers are available for precise control of strain

High Strain Rate Test Facility

Research Area: Mechanical Properties Evaluation

Recent automobile safety regulations and subsequent development of analytical models for automobile crash events have mandated the need for realistic constitutive data at high strain rates. This data is required as inputs for computational design models. If accurate numerical simulations can be obtained from computational models and high strain rate data, the expensive crash tests may be dramatically reduced. This not only translates into significant cost savings, but also will allow the automobile manufacturer to make minor adjustments in their design in a more timely and efficient manner. Keeping in view, a state-of-the-art high strain rate test facility is made available for industrial applications.

Equipment Information

- Model & Make: VHS, Instron
- Year of Installation: 2010
- Applications: Automotive crash, high-speed forming
- Resolution & Range: 250 kN - 20 m/s
- Sample: Flat tensile, metallic cans, disc

Servo-Electric Dynamic Test Machines

Research Area: Mechanical Properties Evaluation

Similar to servo-hydraulic test machines, the servo-electric dynamic test frames are also with closed loop controllers and capable of performing all kinds of tests as in former. The difference, however, being the closed loop DC servo-motor that makes the system suitable for long term operations. NML has 2 Nos of 10 T servo-electric dynamic machines with all accessories and high temperature (up to 900°C) and environmental chamber (300°C to - 150°C). Due to its long-term operational capabilities, the system is very useful for studying, creep-fracture interaction, corrosion fatigue crack growth studies, low cycle fatigue or any such tests that involves long test duration and/or require low frequency cycling

Equipment Information

- Model & Make: Instron 8865
- Year of Installation: 1995
- Applications : Evaluate a variety of mechanical properties such as tensile, fatigue crack growth, fracture toughness and low cycle fatigue at a range of temperatures
- Resolution & Range: 100 kN
- Sample: Round/Flat (tensile, LCF); CT/TPB (FCGR, Fracture)

Miniature Specimen Test System

Research Area: Mechanical Properties Evaluation

Equipment Information

- Model & Make: Electropulse 3000, Instron UK
- Year of Installation: 2010
- Applications: tensile, high and low cycle fatigue, fracture toughness (KIC, JIC), and fatigue crack growth rate (FCGR)
- Resolution & Range: Dynamic Capacity: 3 kN; Static Capacity: 2.1 kN; (load cells with 1000 N, 500 N are also available); Freq: 0.1 Hz to 300 Hz
- Sample: Flat /round specimens of 0.1 to 6 mm thickness / 3-6 mm grip diameter, TPB: 5 mm x 5 mm x 25 mm, Disc/CT: 12.5 mm width x variable thickness

Miniature Specimen Test System is a dynamic testing machine exclusively for studying the mechanical behaviour of materials using small specimens. The system is capable of performing both static and dynamic testing of a variety of materials. Due to the high dynamic performance, the system can operate even at frequencies greater than 100 Hz, which makes the fatigue testing easy.

Various types of testing that are possible with this system are tensile, high and low cycle fatigue, fracture toughness (KIC, JIC), and fatigue crack growth rate (FCGR) studies, all using a small volume of material. The system is ideal for industries that cannot spare a large volume of material that is typically required in destructive experiments and for those research organizations who are desirous to know the behaviour of materials across the length scale.

Tension-Torsion Test System

Research Area: Mechanical Properties Evaluation

This unique facility is the first of its kind in the country. Deformation behaviour of materials can be studied under combined axial-torsional load paths with or without applying an internal pressure on tubular specimens. The two load paths can be controlled either in-phase or out of phase. The information generated is useful for understanding the deformation behaviour of material under multiaxial loading conditions in stress state situations analogous to those of actual components. The system has an axial capacity of +/- 100 KN and torsional capacity of 1000 Nm. The maximum internal pressure that can be applied using a special unit is 600 bar. The system also has a bi-axial extensometer for precise control/measurement of axial and shear strains.

Equipment Information

- Model & Make: Instron 8850
- Year of Installation: 2006
- Applications: To characterize cyclic deformation behaviour under multiaxial proportional/non-proportional loading conditions
- Resolution & Range: 100 kN axial; 1000 Nm torque
- Sample: Tubular specimens of 25 mm outer diameter in the gauge section and 32 mm diameter in end section

Servo-Hydraulic Mechanical Testing Systems

Research Area: Mechanical Properties Evaluation

Equipment Information

- Model & Make: Instron 8800
- Year of installation: 1995
- Applications: Evaluate a variety of mechanical properties such as tensile, fatigue crack growth, fracture toughness, and low/ high cycle fatigue
- Resolution & Range: 50 kN and 100 kN
- Sample: Flat, round (tensile, fatigue), CT/TPB (fracture, FCGR)

NML has a total of 5 servo-hydraulic dynamic test machines with various capacities. 2 each of them are of 10 T and 5 T capacity, and one is of 50 T capacity. All systems are with latest closed loop controllers attached to computers for automatic test programming and data acquisition. A variety of grips and fixtures are available for performing tensile tests, fatigue (push-pull) tests, fatigue crack growth studies and fracture toughness estimations, using flat, round (both threaded and smooth ends), three-point bend and compact tension specimens. Extensometers and/or COD gauges for all these tests are also available. Apart from this, in situations where these gauges cannot be used, an ACPD or DCPD unit is also available for crack length measurements.

Creep Fatigue Test Frames

Research Area: Mechanical Properties Evaluation

CSIR-NML has 3 numbers of dedicated Creep-Fatigue Test systems of 3.2 T and 10 T capacity with furnace (1100^{o}C) and side entry type high temperature extensometer. The function generator of the system can produce different types of waveforms with long hold time (100 hrs) at either or both peaks.

Equipment Information

- Model & Make: Instron / BiSS
- Year of Installation: 2011 / 2019
- Application: Creep-Fatigue Interaction
- Resolution and Range: 32 kN and 100 kN
- Sample: Round Cylindrical

Creep Crack Growth Test Frames

Research Area: Mechanical Properties Evaluation

Equipment Information

- Model & Make: Zwick-Roell
- Year of Installation: 2017 and 2019
- Application: Creep-Crack Growth
- Resolution and Range: 100 kN
- Sample: Full/Half CT specimens

CSIR-NML has 5 numbers of dedicated Creep-Crack Growth Test systems of 10 T capacity with furnace (1100°C), high temperature FLD gauge, and DCPD arrangement. The systems are capable of conducting long-term studies on the behavior of cracks under creeping conditions and evaluation of C* fracture parameter.

Ultrasonic Flaw Detector with Analog Output

Research Area: Non-destructive Evaluation

Ultrasonic flaw detector is used to evaluate materials in terms of defects, discontinuities, cracks etc. Various types of elastic modulus can also be determined by evaluating longitudinal and shear wave propagation velocities in materials. Frequency range of the system is up to 25 MHz with a maximum pulser voltage of 450 V. The system is equipped with an analog output port which can be used to save ASCII data for further analysis.

Equipment Information

- Model & Make: Krautkramer USN 60; GE Inspection Technologies
- Year of Installation: 2016
- Application: Flaw detection, thickness measurement in various materials (Metallic, ceramic, composites), elastic modulus determination.
- Thickness Range: 1 mm to 30 m at steel velocity
- Sample: Flat surface

Computer-Controlled 3-Axis Ultrasonic Scanning System

Research Area: Non-destructive Evaluation

The Motorized 3-Axis (X, Y, Z) Ultrasonic Immersion Scanning System, along with UTwin software, is designed to examine defects within materials in a nondestructive manner through ultrasonic imaging. This system comprises an ultrasonic pulser/receiver, a high-speed computer-controlled mechanical scanner, an ultrasonic transducer/probe, and an immersion tank Ultrasonic C-scan system is used to identify the cleanliness of materials in terms of inclusions, defects etc., through 2D and 3D images. The frequency range of the system is up to 20 MHz. This system can be used to find the macrostructure of cast materials, inclusion distribution at different depths, pit size and depth distribution, central quality evaluation of cast billets & blooms, etc. along with defect quantification in terms of size, count, location.

Equipment Information

- Model & Make: Physical Acoustics
- Year of Installation: 2007
- Resolution & Range: 25 m spatial resolution
- Sample: Solid sample with two flat parallel faces of any shape

Computerized 4-Axes (X, Y, Z, θ) Ultrasonic Immersion Scanning System

Research Area: Non-destructive Evaluation

The Motorized 4-Axis (X, Y, Z & θ) Ultrasonic Immersion Scanning System, along with UTwin software, is designed to examine defects within materials in a nondestructive manner through ultrasonic imaging. This system comprises an ultrasonic pulser/receiver, a high-speed computer-controlled mechanical scanner, an ultrasonic transducer/probe, and an immersion tank. In addition to ultrasonic imaging of flat parallel plates and block specimens, this 4-axis ultrasonic scanning system is also capable of scanning cylindrical rods and pipes of uniform dimensions. Scanning of external as well as internal surface of hollow pipes can also be done. Defects counts, size and location can precisely determined. This system can be used to find the macrostructure of cast materials, inclusion distribution at different depths, pit size and depth distribution, central quality evaluation of cast billets & blooms, etc, bond quality assessment of joined structure etc.

Equipment Information

- Make: NDTT, Mumbai / Mistras, USA
- Year of Installation: 2021
- Application: Ultrasonic scanning, detecting & imaging of defects/ discontinuities in materials.
- Resolution: 0.04 mm (spatial and angular)
- Frequency: up to 35 MHz
- Sample: Flat/Cylindrical specimen

High Power High Frequency Ultrasonic System

Research Area: Non-destructive Evaluation

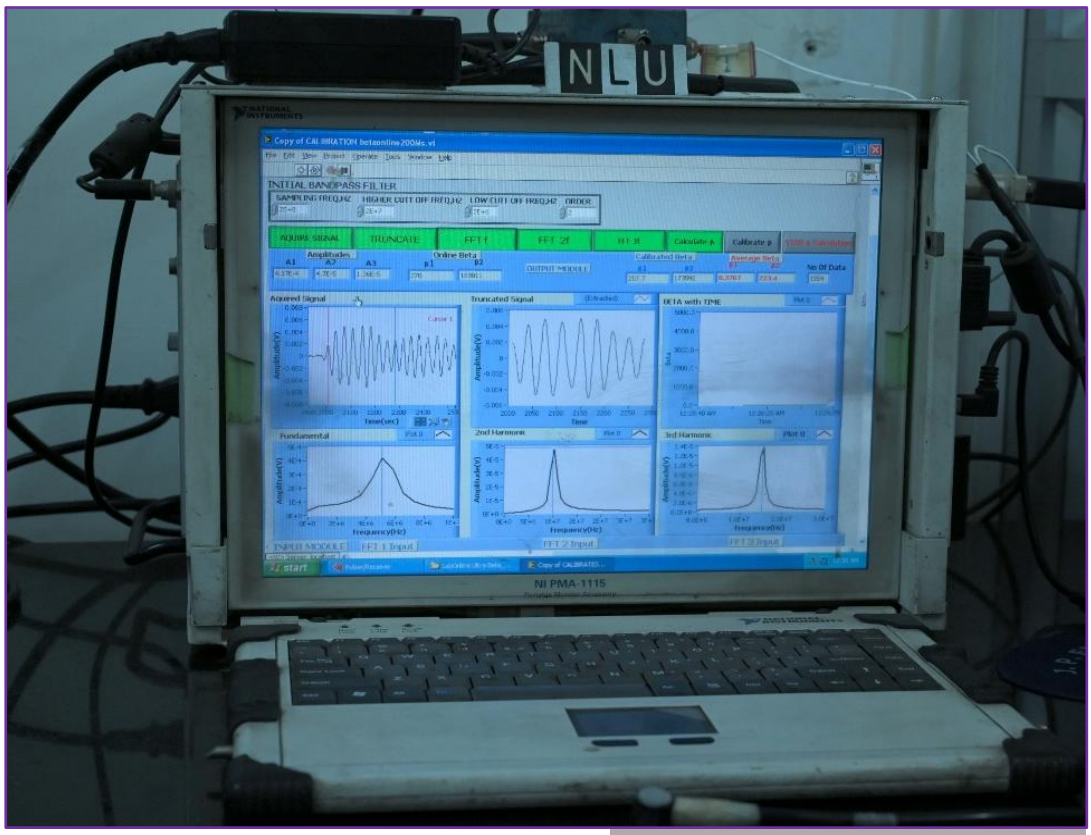
It is a high-power RF tone burst generator with an output of 5 kW up to 7 MHZ. The system operates at a Frequency Range of 40 kHz - 20 MHz. It can be used to characterize material by measuring non-linear properties. It examines harmonic frequencies for increased sensitivity in material evaluation

Equipment Information

- Model & Make: RAM 5000, RITEC
- Year of Installation: 2006
- Applications: Damage evaluation of materials using harmonic analysis and generation of high-voltage tone burst signals to excite PZT, EMAT or magnetostrictive sensors
- Sample: Flat samples of thickness > 4 mm

Portable Nonlinear Ultrasonic Device

Research Area: Non-destructive Evaluation



Portable nonlinear ultrasonic device is a single unit solution for concrete to metals. It can be used as conventional ultrasonic system as well as a high power pulser for EMAT, guided wave ultrasonic and nonlinear ultrasonic. Software Calβ, has been developed in-house for online NLU parameter determination along with calibration, data saving and report generation modules.

Equipment Information

- Model & Make: Custom-made portable nonlinear ultrasonic device (Designed & developed at CSIR- NML)
- Hardware: Pulser Power- 5 KW at 5 MHz; Pulser Voltage- up to 1200 Volt; sampling rate- 2 Gs/S; pulser frequency- 100 KHz to 6 MHz
- Application: Online assessment of structural damages in industrial components.
- Sample: Flat specimen of thickness > 4 mm

Ultrasonic System with Time-of-Flight Diffraction and Phased Array

Research Area: Non-destructive Evaluation

Ultrasonic system with Time-of-flight diffraction (TOFD) is a technique that uses two probes in pitch-catch mode and detects and records signals diffracted from defect tips allowing both detection and sizing. The TOFD data is displayed in a gray scale B-scan view. TOFD offers wide coverage and amplitude-independent sizing complying with the ASME 2235 code.

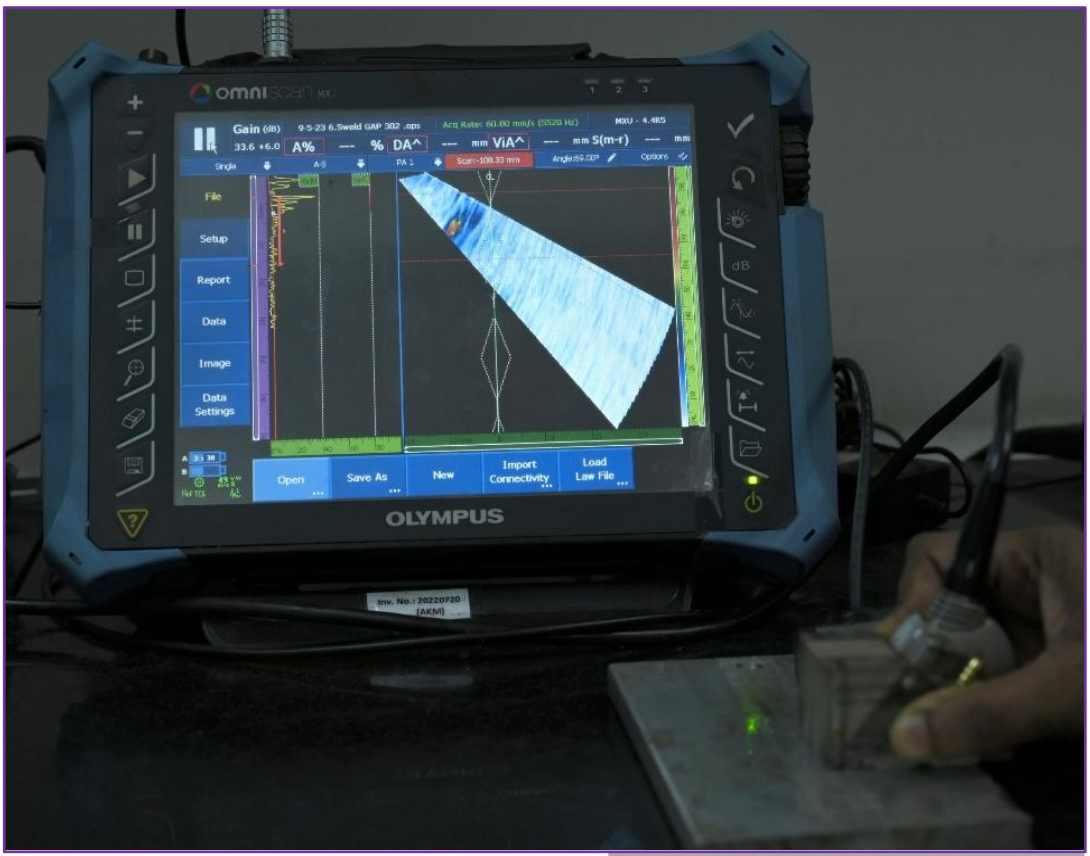
- One-line scan for full-volume inspection
- Setup independent of weld configuration
- Very sensitive to all kinds of defects and unaffected by defect orientation

Equipment Information

- Model & Make: OMNISCAN, RD Tech, Olympus
- Year of Installation: 2007
- Applications: Girth Weld Inspection, Pressure vessel weld inspection
- Sample: Flat welded samples, Pressure vessels

Ultrasonic Phased Array System

Research Area: Non-destructive Evaluation



Phased Array Ultrasonic system is an advanced nondestructive testing method which uses array of transducers to steer and focus beams electronically, enabling detailed inspection of materials and structures without causing damage. Ultrasonic beams can be steered, scanned, swept and focused without moving the transducers that makes this technique superior to conventional angle beam ultrasonic technique.

Equipment Information

- Model & Make: OmniScan MX2; Olympus, USA
- Software: OmniPC and TomoView
- Year of Installation: 2022
- Application: Girth weld inspections; pressure vessel weld inspections; composite inspections
- Aperture: 32 elements
- Number of elements: 128 elements

Precision Impedance Analyzer

Research Area: Electrical Properties Evaluation

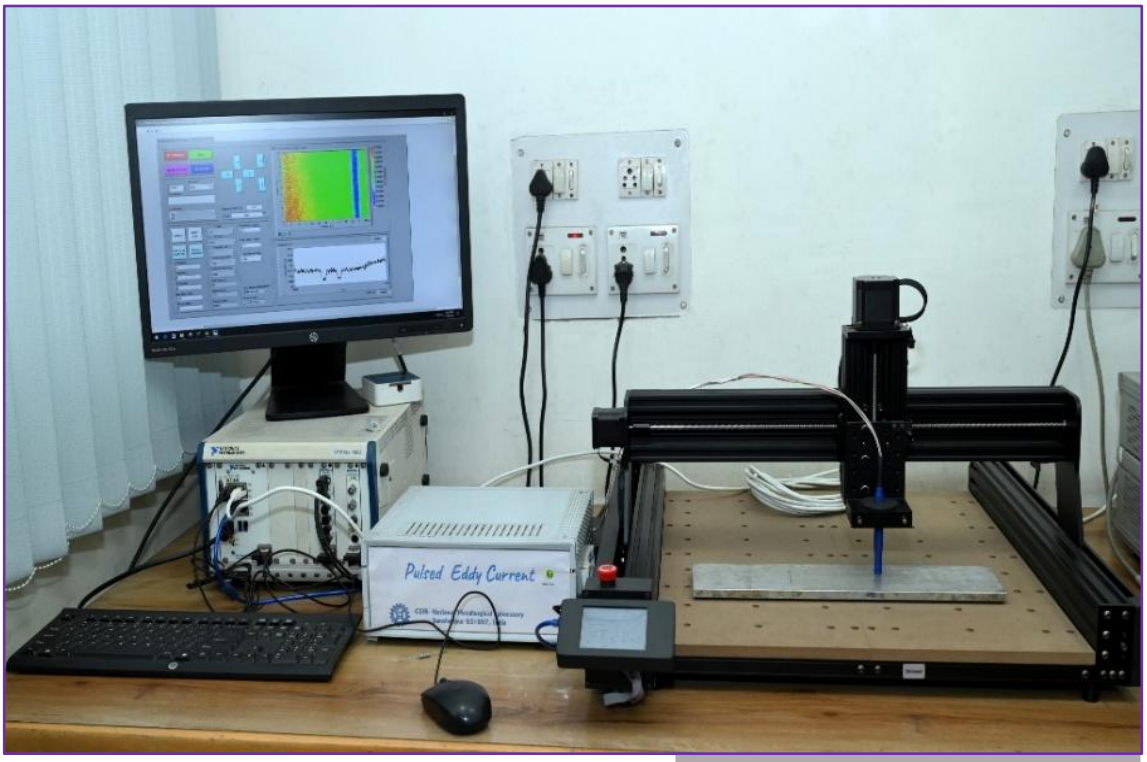
The 4294A precision impedance analyzer is an integrated solution for efficient impedance measurement and analysis of components and circuits. The 4294A covers a broader test frequency range (40 Hz to 110 MHz) with Basic impedance accuracy: +/-0.08 %. Excellent High O/Low D accuracy enables analysis of low-loss components. The wide signal-level ranges enable device evaluation under actual operating conditions. The test signal level range is 5 mV to 1 V rms or 200 uA to 20 mA rms, and the DC bias range is 0 V to +/-40 V or 0 mA to +/-100 mA. Advanced calibration and error compensation functions eliminate measurement error factors when performing measurements on in-fixture devices. The 4294A is a powerful tool for design, qualification, quality control, and production testing of electronic components.

Equipment Information

- Model & Make: 4294 A, Agilent
- Year of Installation: 2005
- Applications: To measure Impedance, Phase, Parallel and Series Capacitance, Parallel and Series Inductance, Dielectric loss, O-factor, Dissipation Factor, Permeability, etc. of electric/ferro-electric materials
- Sample: flat samples of square or round shape with conducting coating on both surfaces. Preferred with leads.

Automatic Eddy Current Inspection System

Research Area: Non-destructive Evaluation



The automatic eddy current inspection system comprises a customized eddy current probe, an advanced instrumentation system, and a 3D scanner designed for the integrity assessment of both magnetic and non-magnetic engineering components. The system's graphical user interface (GUI) is developed on the NI LabVIEW platform, seamlessly integrating the instrumentation system and the 3D scanning unit within an NI PXI framework. This system is engineered to enhance automation and data processing, significantly improving defect detection accuracy and efficiency. The final inspection results are visually represented, ensuring intuitive and precise interpretation.

Equipment Information

- Model & Make: Custom made EC probe and instrumentation system interfaced with NI PXI system and 3D scanner.
- Year of Installation: 2020
- Application: Integrity assessment of components
- Depth resolution: 200 µm;
- Penetration depth: 0 to 5 mm
- Sample: Flat specimen (magnetic & non-magnetic)

IR Camera with Lock-in Thermography

Research Area: Non-destructive Evaluation

The computer-controlled thermography system is used to detect the inhomogeneities in the sample. Typical field of applications of this system are Material inspections, Quality Control & Process monitoring, Predictive maintenance, Gas Leak detection, thermographic inspection of electrical and mechanical systems and aggregates, Detection of layer structures, delamination and inserts within plastics, composites, etc.

Equipment Information

- Model: VariocamHD IR Camera
- Make: Infratec GmbH,
- Software: IRBIS3 active online
- Year of Installation: 2012
- Application: Quality control & process monitoring, thermographic inspection of various structural materials.
- Resolution and Range: 2 mK; 40°C to 1200°C
- Sample: Flat specimen

Engineering

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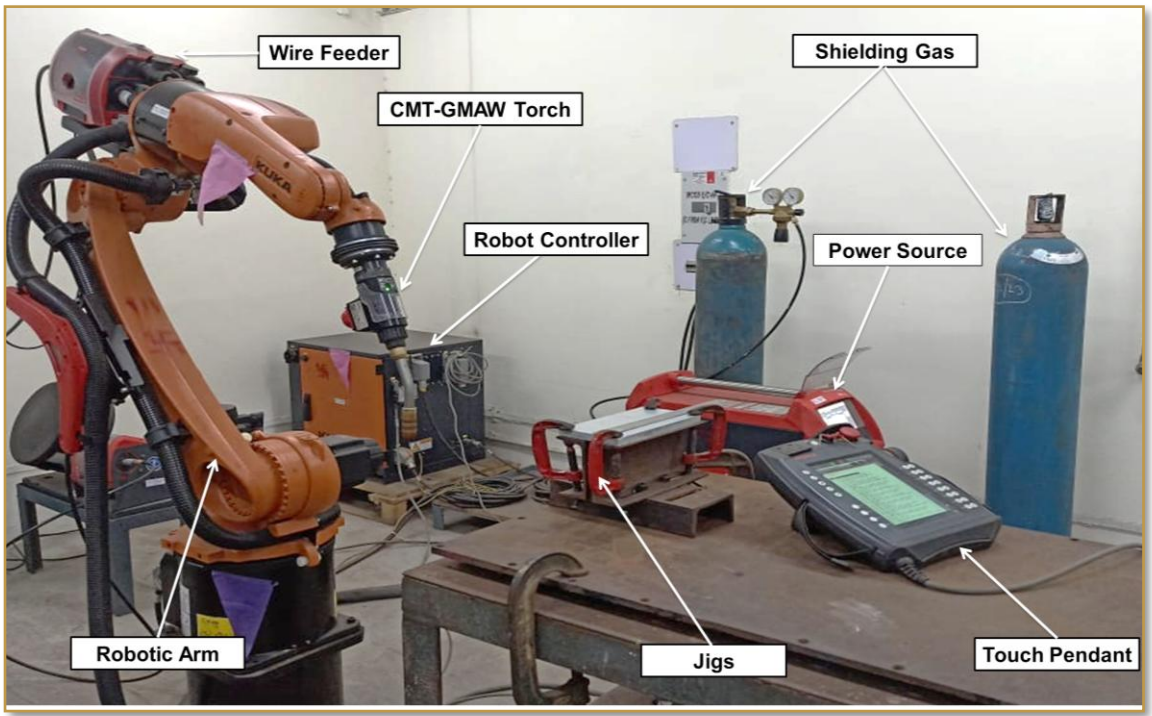
Robot Integrated Pulse Synergic MIG/MAG Welding Equipment

Research Area: Wire Arc Additive Manufacturing



Wire Arc Additive Manufacturing (WAAM) is an advanced direct energy deposition (DED) process used to fabricate large-scale 3D metal or alloy parts with high productivity and cost-effectiveness.

In this process, a robotic system equipped with a Gas Metal Arc Welding (GMAW) torch, specifically the Cold Metal Transfer (CMT) variant, is employed to deposit molten metal from a wire feed. The system typically includes a wire feeder, the CMT-GMAW torch, a robotic arm, a robot controller, and a touch pendant for operator interaction. The combination of these components allows for precise control over the deposition of material, enabling the creation of complex geometries and parts with high dimensional accuracy.

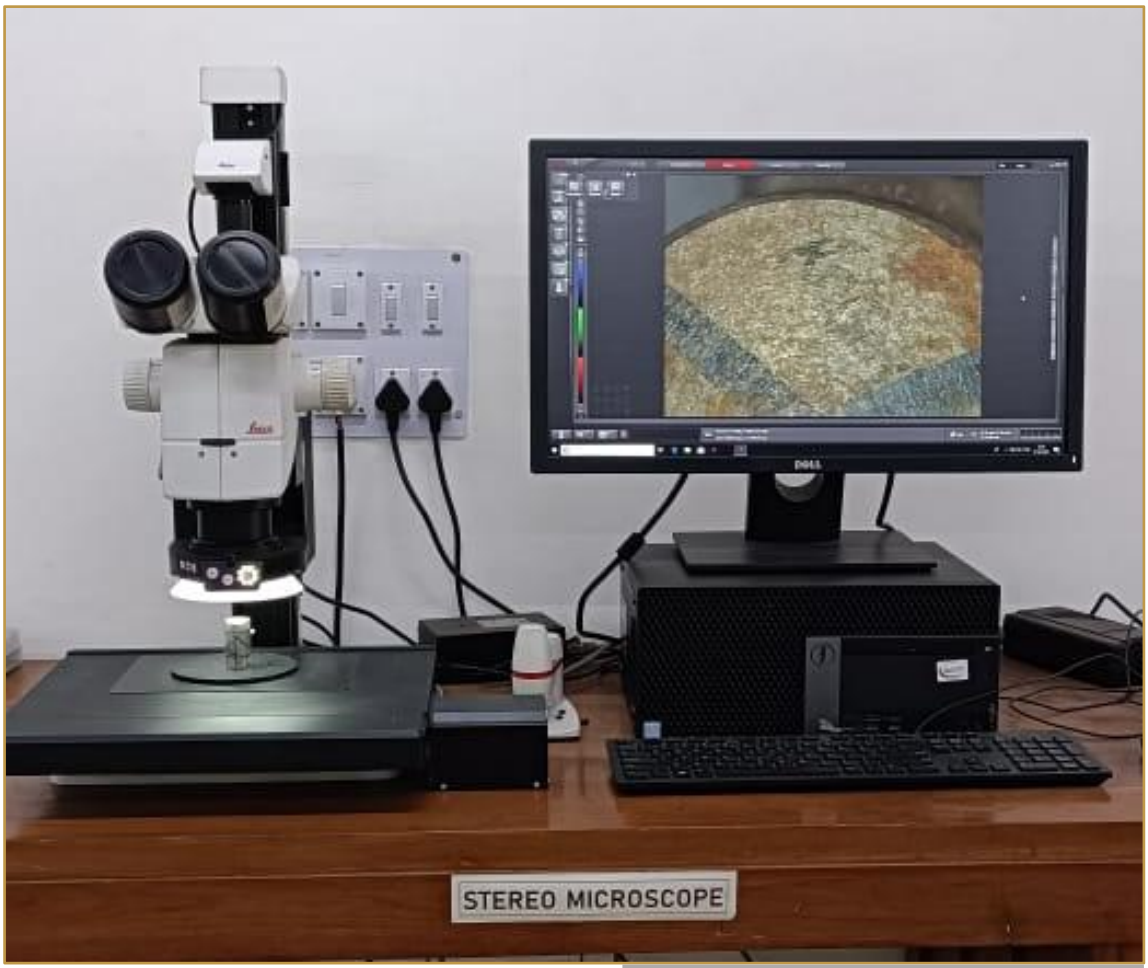
During the deposition process, consumables such as shielding gas, wire feed, and specialized jigs are required. WAAM technology is especially suited for applications in industries like aerospace, automotive, and heavy machinery, where large parts need to be manufactured quickly and cost-effectively.

Equipment Information

- Model & Make: Robot Integrated Pulse Synergic MIG/MAG Welding Equipment-500A
- Welding power source TPS 500i [Fronius] and Robot : R1620 arc HW [KUKA]
- Year of Installation: 2019
- No. of axes: 6
- Maximum reach: 1421 mm

Stereo Microscope

Research Area: Materials Characterization



Magnification: Approximately 4x to 50x (depending on zoom setting and objectives)
Objectives: Adapter with 0.5x and 1.0x objectives for different working distances and magnifications
Optical System: Leica True Vision optics for bright, clear, and color-accurate images
Zoom: Continuous zoom (typically 20.5x), allowing smooth adjustment between magnifications
Eyepieces: 10x widefield, 22 mm field of view
Working Distance: Large, suitable for manipulating specimens or tools
Illumination: LED transmitted and incident lighting with adjustable brightness
Stage: Mechanical stage for precise movement
Focus: Coarse and fine focusing mechanisms

Equipment Information

- Model & Make: Leica M205 C optics carrier
- Eyepiece 10x/23B, adjustable, 2nd gen
- Objective plan M-series (0.5x and 1.0x (available one at a time)
- Motor focus drive long 620 mm M-series
- Motorized IsoPro 6x4″ XY stage
- Inc. light base, large w. Antishock feet.
- Applications: Suitable for industrial inspection, biological research, educational purposes, and material analysis

Madras Center

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Laser Particle Size Analyzer

Research Area: Materials Characterization

The Laser Particle size analyzer is used to measure the particle size distribution of a sample. It utilizes Helium-Neon laser beam diffraction for the measurement and also considers that the particles are spherical in nature. The analysis involves both dry and wet modes of operation, depending upon the nature and size of the particles. This instrument measures particle size ranging from 0.04 to 2500 µm.

Equipment Information

- Model & Make: M/s CILAS 1180, France
- Year of Installation: 2002
- Sample: Powder & slurry

Surface Area Analyzer

Research Area: Materials Characterization

The surface area analyzer is used to measure the single and multipoint BET (Brunauer, Emmett& Teller) surface area and Langmuir surface area by the adsorption of nitrogen gas on the sample's surface. The amount of gas adsorbed at a given pressure determines the surface area. Pore volume and pore area distributions in the mesopore and macropore range by BJH (Barrett, Joyner & Halenda) method using user-defined standard isotherm can be obtained. Micropore distribution by MP method and total micropore volume by the t-plot method can be measured.

Equipment Information

- Model & Make: M/s Micromeritics ASAP 2020, USA
- Year of Installation: 2005
- Sample: Powder & solids

Zeta Sizer

Research Area: Materials Characterization

The zeta sizer is a combined acoustic and electroacoustic spectrometer for characterization of particle size and zeta potential of dispersions and emulsions. Zeta potential is determined by measuring colloid vibration current that results from displacement of electrical double - layer of charged particles under influence of ultrasound. The pH range variation is from 0.5 to 13 and particle size measurement ranges from 0.005 µm to 1000 µm.

Equipment Information

- Model & Make: M/s Dispersant Technology DT-1200, USA
- Year of Installation: 2006
- Sample: Powder & slurry

Metallurgical Microscope With Image Analyzer

Research Area: Microstructural Characterization

Equipment Information

- Model & Make: M/s Leica DMLM metallurgical microscope, Germany
- Year of Installation: 2000
- Sample: Metallographically polished (mirror finish) samples up to a maximum size of 20 mm x 20 mm and thickness 1-10 mm.

Metallurgical microscope is used to study the structure of metallographically prepared metal /alloy samples at magnifications > 50X. The studies include determination of grain size, nature and distribution of various inclusions, size, shape, and distribution of various phases, and their spacing, etc. Coating thickness, Depth of decarburization, etc., can also be determined. Using the dedicated digital camera attached to the microscope, the live images are captured and saved onto digital media for easy use and data storage.
The Leica QWin Image Analyzer can be employed for quantitative metallography studies and to obtain reliable, quick, and reproducible results.

Rheometer

Research Area: Materials Evaluation

Equipment Information

- Model & Make: M/s Anton Paar Physica MCR 101, Germany
- Year of Installation: 2005
- Sample: Powders, solids & slurry

Rheological tests, both in rational and oscillatory modes, can be determined using a rheometer. It measures viscosity, flow curves, yield point, and thixotropy of the sample. Viscoelastic behavior as a function of shear stress, time, and temperature (RT to 250°C) for liquids can be measured by an oscillatory test method. The measurement method involves both cone and plate types of operation, depending upon the viscous nature of the sample.

Gas Pycnometer

Research Area: Materials Evaluation

The gas pycnometer is used to measure the true density of the sample by gas (helium) displacement method.

Equipment Information

- Model & Make: M/s Micromeritics AccuPycII 1340, USA.
- Year of Installation: 2007
- Sample: Powders & solids

Micro Indentation Hardness Tester

Research Area: Microstructural Evaluation

Equipment Information

- Model & Make: M/s Leica VMHT Microindentation Hardness tester, Germany
- Year of Installation: 2000
- Sample: Metallographically polished (mirror finish) samples up to a maximum size of 20 mm x 20 mm and thickness 1-10 mm.

Micro indentation hardness testing (also called as microhardness testing) is the hardness testing of materials with low applied loads (1 to 1000 gf) and widely used to determine hardness of metals/alloys at microscopic scales. The test can be employed to determine the hardness of surface coatings, case hardened steels, hardness of decarburized surfaces etc. It is also used to determine the hardness of individual phases/ constituent particles present in the metals and alloys.

Tensiometer

Research Area: Materials Evaluation

The tensiometer is used to measure the contact angle of solids, powders, and fibre bundles. Surface free energy calculation can be determined from the contact angle data. The surface tension of liquids and, interfacial tension between two liquids can be measured. The measurement method involves both ring and plate (with highly accurate contours) modes of operation. The measurements can be made between temperatures varying from RT to 130°C.

Equipment Information

- Model & Make: M/s Kruss K 100, Germany
- Year of Installation: 2004
- Sample: Powders, solids & liquids