



EQUIPMENT Facility

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CSIR-NML

*Meenakshi
Joshi*

Overview of CSIR-NML

The foundation stone for National Metallurgical Laboratory was laid by Hon'ble Sri C. Rajagopalachari on 21st November, 1946. It was formally inaugurated and dedicated to the nation on 26th November, 1950 by Pandit Jawaharlal Nehru *"in a spirit of hope and in a spirit of faith in the future"*. The laboratory was an element of Sir Shanti Swaroop Bhatnagar's vision of providing India with a network of research institutions for taking the country ahead in science and technology. CSIR-NML played a significant role in the industrial revolution of India starting from 1950 especially in the areas of mineral processing, iron and steel making, ferroalloys and extraction of non-ferrous metals, notably magnesium. Asia's largest creep testing facility was also set up at CSIR-NML in the early 1970s and even today it ranks as the second largest creep testing lab in Asia. 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.

Since inception CSIR-NML has diversified its research areas ranging from mineral beneficiation and processing, indigenous alloy development, extractive metallurgy, refractories, corrosion, mathematical and physical modeling of metallurgical processes, advanced materials and materials tailoring, integrity evaluation of critical industrial components and cleaner and sustainable metals production. CSIR-NML is also carrying out major activities for creating awareness among the common masses on issues relating to health, environment, rural technology and sustainable development.

With a strong and committed staff having a wide spectrum of expertise and modern facilities, CSIR-NML endeavors to move ahead to meet the challenges of the global economy and reach greater heights.

Vision

To become a global leader and an internationally benchmarked laboratory in mineral and metallurgical research and development

FOREWORD

Equipment facility, manpower and organizational processes are the 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 highlights research & testing facilities available at CSIR-National Metallurgical Laboratory (NML). The facilities presented in this brochure generate precision data of scientific experiments, carry out processing of minerals, metals and materials, evaluate and characterize the same for varied applications, and aid in development of advanced materials technologies.

The minerals, materials and metallurgical community may take advantage of this equipment brochure for utilizing the facilities at CSIR-NML.

TEST FACILITIES

Chemical Analysis

No.	Description
CA1	Analytical tests
CA1a	First One to four elements
CA1b	For every subsequent element
CA1c	Complete analysis (Quantitative/Semi quantitative/ Qualitative)
CA1d(i)	Hydrogen, Oxygen, Nitrogen content in metal sample
CA1d(ii)	Oxygen & Nitrogen in single Metal sample
CA1e	Calorific Value in Coal & Coke
CA1f	Particle size: Aqueous suspension (0.6 nm to 5 m)
CA1g	Zeta potential: Aqueous suspension (0.6 nm to 5 m)
CA1h	Iso-Electric Point: Aqueous suspension (0.6 nm to 5 m)
CA1i(l)	Water Analysis for ground water/ drinking water/ effluent water: First One to Ten radicals (Colour, PH, Conductivity, Acidity/alkalinity, Total dissolved solids, Total Hardness, Turbidity, Chloride, Iron, Calcium, Magnesium, Manganese, Zinc, Fluoride, Nitrate, Sulphate, Bromide, Phosphate, Iodide, Nitrite, Nickel, Chromium, Lead, Cadmium, Copper, Cobalt, aluminium, Molybdenum, Boron, Barium, Ammonium, Sodium, Potassium, Lithium, Arsenic, Mercury, Silicon, Selenium etc.)
CA 1 i (ii)	For every subsequent radical in water sample
CA 1 j	Speciation analysis: (i) As(III) and As(V) in water (ii) Se (IV) and Se (VI) in water
CA 1 k (i)	Trace Metal analysis by ICP-Mass: First One to four elements
CA 1 k (ii)	For every subsequent element by ICP-Mass
Ca2	FTIR spectra Range: 400-4000cm ⁻¹ , Sample type: solid powder or liquid
Ca3	UV-visible spectra (liquid sample only, 200-900nm)



TEST FACILITIES

Corrosion Tests

No.	Description
CT1	Salt spray test
CT2	Copper strip corrosion test
CT3	Stress corrosion test
CT4	Wheel test for inhibitor
CT5	Hydrogen permeation test (Ambient temp.)
CT6	Exfoliation corrosion
CT6a	(EXCO) test for Aluminum alloys
CT6b	ASSET Test
CT7	Intergranular corrosion susceptibility in stainless steels
CT7a	Oxalic acid etching
CT7b	Ferric Sulfate- Sulfuric acid
CT7c	Boiling nitric acid test
CT7d	Copper sulfate- sulfuric acid
CT7e	Copper sulfate- sulfuric acid
CT8	Stress corrosion cracking test in boiling magnesium chloride
CT9	Pitting and crevice corrosion resistance of stainless steels and related alloys by use of ferric chloride solution
CT10	
Ct10a	by Single loop electrochemical potentiokinetic reactivation test
Ct10b	by double loop electrochemical potentiokinetic reactivation test method
CT11	Electrochemical Impedance
CT12	Measurement of Corrosion potential of Al-alloys-
CT13	Evaluation of IGC resistance of Al-alloys
CT14	Evaluation of IGC resistance of Al-alloys
CT15	High temperature oxidation
CT16	Anodic/Cyclic polarization test
CT17	Electrochemical Impedance with time up to 10 days

TEST FACILITIES

Microstructural Characterization

No.	Description
MC1	Metallography
MC1a	Examination of microstructure and macrostructure including cutting, grinding and preparing the specimen and interpretation of results with photograph
MC1b	Metallography (quantitative)
MC2	SEM / FEG SEM
MC2a	SEM - EDS
MC2b	SEM - EBSD
MC2c	Sample preparation
MC3	XRD
MC3a	Qualitative XRD
MC3a(i)	Qualitative X-ray diffraction for normal 2 deg./m diffractogram (without interpretation)
MC3a(ii)	Identification (presence/absence of up to 5 specified phases)
MC3a(iii)	Identification (presence/absence of each additional phases)
MC3b	Quantitative estimation of crystalline phases (standard to be given by party)
MC3c	Residual Stress
MC3c(i)	Residual stress by XRD
MC3c(ii)	In-situ residual stress on-site
MC4	TEM
MC4a	TEM examination plus EDAX micro-analysis
MC4b	TEM sample preparation
MC5	AFM
MC6	EPMA (WDX/EDX)



TEST FACILITIES

Mechanical Property Evaluation

No.	Description
ME1	Impact test on Notched Charpy
ME1a	At room temp. on prepared specimen
ME1b	At sub-zero temperature up to -50 deg. C on prepared sample
ME1c	Extra charge for charpy sample preparation
ME2	Hardness tests
ME2a	Vicker/Brinell/Rockwell/Pyramid
ME2b	Microhardness test
ME2c	Nanoindentation
ME3	Tensile Test
ME3a	At room temperature on prepared sample
ME3b	At high temperature up to 750 °C on prepared sample
ME3c	Sub-zero temp. up to -50 °C on prepared sample
ME3d	Room temp. tensile test for wire (Dia. 100 m to 6 mm) and sheets (thickness: 50 m to 5 mm) with 25kN Load Cell for prepared samples
ME3e	Sub-zero temp. (down to -70 C) tensile test for wire (Dia. 100 m to 6 mm) and sheets (thickness: 50 m to 5 mm) with 25kN Load Cell for prepared samples
ME3f	Tensile test at high strain rate upto 103 s-1
ME4	Compression Test
	At room temp. on prepared sample (cube or cylinder)
ME5	Fracture Toughness
ME5a	Fracture toughness test (K _{ic}) at RT on prepared specimen
ME5c	Fracture toughness test (J _{ic}) at RT on prepared specimen
ME5b	Fracture toughness test (K _{ic}) at HT (up to 300° C) on prepared specimen
Me5d	Fracture toughness test (J _{ic}) at HT (up to 300° C) on prepared specimen

TEST FACILITIES

Mechanical Property Evaluation

No.	Description
ME5e	Extra charge for preparing test samples
ME6	Fatigue test and FCGR
ME6a	High cycle fatigue tests
ME6b	S-N curve generation (20 specimens will be tested)
ME6c	Low cycle fatigue at RT
ME6d	Low cycle fatigue up to 500oC
ME6e	Low cycle fatigue at -50 oC
	Low cycle fatigue above 500 and up to 1000 °C on prepared specimens
ME6f	Extra charge for fatigue sample preparation
ME6g	Fatigue crack growth at RT on prepared specimen
	Extra charge for FCGR specimen making
ME7	Creep Test
ME7a	Stress rupture test up to 700 °C
ME7b	Creep test up to 700 °C
ME7c	Creep or stress rupture test above 700 °C (Max.1100 °C) on prepared specimen
ME7d	Specimen making charge
ME8	Tribological/ Erosion tests
ME8a	Air Jet Erosion test at Room Temperature
ME8b	Air jet erosion at 50-500 C
ME8c	Nano-tribimeter



TEST FACILITIES

Mineral Processing & Characterization

No.	Description
MN1	Surface Property
MN1a	BET surface area only
MN1b	Complete BET analysis including BET surface area, mesopore size distribution, pore volume and average pore diameter
MN1c	Contact Angle Measurement (at room temp. to 60°C)
MN2	Mineral Characterisation
MN2a	Identification only
MN2b	only Optical Microscopy
MN2c	Optical microscopy, liberation
MN2d	Including XRD,SEM Etc
MN3	Carbon coating
MN4	DTA & TG Analysis
MN5	Bond's work index determination
MN5a	Bond's work index determination-Ball Mill
MN5b	Bond's work index determination-Rod Mill
MN6	Hardgroove Grindability Index (HGI)
MN7	Filtration Studies
MN7a	Filtration Studies –Leaf tests
MN7b	Filtration Studies –Drum tests
MN7c	Filtration Studies –Pressure tests
MN8	Settling tests
MN9	Heavy media test (3 diff. Densities up to 3.3)
MN10	Washability Tests for Coal for one size range up to 0.5 mm
Mn11	Crushing strength- rocks

TEST FACILITIES

Mineral Processing & Characterization

No.	Description
MN12	Size analysis
MN12a	size analysis (cyclosizing)
MN12b	size analysis (instrumental- laser, 1 to 1000 micron)
MN12c	size analysis (200 mm to 325 mesh) dry or wet Screening
MN12d	sample preparation only (10 mesh to 200 mesh, up to 500g)
MN12e	Sample preparation (200mm to 200 mesh, up to 500g)
MN12f	Bulk sample preparation after grinding (50 Kg)
MN13	Tumbler test
MN14	Shatter test
MN15	Grindability test
MN16	Bulk density/Sp.Gr
MN17	Zeta potential measurement (below 25 micron), ZPC
MN18	Porosity measurement (Mercury)
MN19	Surface tension Measurement (Liquid sample)
MN20	Proximate analysis of coal
Mn21	Turbidity measurement



TEST FACILITIES

Melting services & related characterization

No.	Description
MS1	Vacuum Induction melting
MS1a	Up to 40 Kg/ heat
MS1b	Up to 20 Kg/heat
MS1c	200gm- 2Kg/ heat
MS2	Air melting
MS3	Arc Furnace melting (50 KVA)
MS4	Submerged Arc melting
MS4a	50 KVA
MS4b	175KVA
MS5	Softening Melting
MS6	Physical Tests
MS6a	RI
MS6b	RDI
MS6c	TDI
MS6d	Decrepitation of lime
MS6e	Bend Test
MS6f	Flattering Test
MS6g	Compression Test
MS6h	Viscosity Measurement
MS6i	Swelling Test
MS6j	Ash Fusion Temperature

TEST FACILITIES

Non-destructive Evaluation

No.	Description
ND1	Ultrasonic testing
ND1a	Ultrasonic flaw detection
ND1b	Ultrasonic thickness measurement
ND1c	Ultrasonic C-Scan measurement
ND1d	Modulus of elasticity measurement by Ultrasonic
ND1e	Ultrasonic flaw detection by TOFD
ND1f	Ultrasonic flaw detection by Phased array
ND2	Radiography
ND3	Eddy current testing
ND4	Magnetic Barkhausen emission

Processing and Heat Treatment

No.	Description
PT1	Vac. Hot Press (Tmax 1200 oC, Loadmax 4 Ton)
PT1a	i) Each test – High density Graphite Die-Punch to be provided by the party)
PT1b	ii) Brazing using above
PT2	Mechanical Processing
PT2a	Forging (0.1 MT for Cold Material)
PT2b	Forging (0.5 – 1.0 MT for Cold Material)
PT2c	Forging (Hot Material)
PT2d	Cold Rolling
PT2e	Hot Rolling
PT2f	Extrusion (only Al and Mg alloys)
PT2g	Wire drawing M/C (Bench Draw) Wire drawing M/C (Drum Draw)
PT3	Heat Treatment
PT3a	Heat treatment (<1000 oC up to 8 h)
PT3b	Heat treatment (1000-1200 oC up to 8 h)



TEST FACILITIES

Physical Property Evaluation

No.	Description
PE1	Magnetic Properties Evaluation
PE1a	A.C. B-H. Loop & determination of Coercive force, maximum permeability, core loss using ring specimen having dimension: OD=30mm, ID=20mm, thickness=5mm
PE1b	Temperature variation of magnetisation/ Curie temperature determination (-180°C to 150°C & RT to 1000°C)
PE2	Vibrating sample magneto meter (Maximum magnetic field 12kG)
PE2a	Room Temp. Magnetisation
PE2b	High temp magnetisation (RT to 1000°C)
PE2c	Low temp magnetisation (-193°C to 150°C)
PE2d	Temperature Variation (RT to 1000°C) of magnetisation and Curie Temperature measurement
PE2e	Temperature Variation ((-193°C to 150°C) of magnetisation
PE3	Electrical Resistivity
PE3a	Temperature variation of electrical resistivity (Room temp to 1000°C)
PE3b	Temperature variation of electrical resistivity (-193°C to 150°C)
PE4	Thermal Properties
PE4a	Differential scanning calorimetry (DSC) from RT to 700°C
PE4b	Specific heat up to 500°C using Differential Scanning Calorimeter (DSC)
PE4c	Thermal diffusivity using laser flash method
PE4d	Specific heat and Thermal Conductivity using laser flash method

TEST FACILITIES

Miscellaneous Tests

No.	Description
EN1	Code & heat-treatment (Heat treatment to diffuse hydrogen out of weld test pieces)
EN2	Coating moisture test (loss in wt. At 120oC for 30 minutes)
EN3	Welding Related Evaluations
EN3a	Welding electrode evaluation: mechanical property, chemical analysis of weld metal, hardness, bend test etc.
EN3b	Welding filler evaluation: mechanical property, chemical analysis of weld metal, hardness, bend test etc.
EN4	Abrasion resistance evaluation of hard facing electrodes

Analytical Chemistry



Ash Fusion Temperature Determinator, AF700 (LECO)

Research Area : 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 : AF700, Leco, USA

Year of Installation : 2013

Applications : Coal Analysis

Resolution & Range : NA

Sample : Ash (1g in powder form)

Atomic Absorption Spectrophotometer (AAS)

Research Area : Chemical Analysis



Atomic absorption spectrometry (AAS) is an analytical technique that measures the concentrations of elements. Atomic absorption is so sensitive that it can measure down to parts per billion of a gram (ppb) in a sample. The technique makes use of the wavelengths of light specifically absorbed by an element. They correspond to the energies needed to promote electrons from one energy level to another higher energy level. AAS has many uses for measurement of metals for Clinical analysis: blood and urine; Environmental analysis: Water, drinks such as wine, beer and fruit drinks; Industry: Raw materials, toxic impurities; Mining: Ores, Minerals etc

Equipment Information

Model & Make : Thermo/iCE 3000 series

Year of Installation : 2010

Applications : Trace elemental analysis in metallurgical and water samples

Resolution & Range : 100 ppb to 1000 ppm

Sample : Sample should be in solution form, standards will be provided by NML

Automated Water Analyser

Research Area : Water Chemistry



Complete and precise profiling of water quality is important for ascertaining conformance of water quality with established norms. Water Research Laboratory at NML, Jamshedpur is housing a Metrohm automated water analyser for operator free water quality profiling comprising pH, conductivity, hardness and cation and anion content in water. NML invites proposals from industries, research organizations and academic institutions for using this facility for testing and research purpose.

Equipment Information

Model & Make : TitrIC (Metrohm)

Year of Installation : 2009

Applications : Water analysis

Resolution & Range : 0 to 5000 $\mu\text{S}/\text{cm}$ for conductivity detectors of Ics.

Sample : Water samples

Bomb Calorimeter

Research Area : Coal Analysis



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 placed in a water bucket containing known volume of water in presence of excess oxygen. The heat produced by the combustion raise the temperature of the water which is used to calculate the calorific value of the fuel.

Equipment Information

Model & Make : 6200, Parr, USA

Year of Installation : 2006

Applications : Coal Analysis

Resolution & Range : 100 to 10000 cal/g

Sample : Solids (1g in powder form)

C H N S Analyzer for Coal

Research Area : Coal Analysis



C H N S analyzer is used for 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 flushing and carrier gas. Some useful applications include ultimate analysis of coal, determining elemental composition of organic compounds to determine molecular formula etc.

Equipment Information

Model & Make : Vario EL III, Elementar, Germany

Year of Installation : 2005

Applications : Coal Analysis

Resolution & Range : 0.1% to 99%

Sample : Solids (0.1 g in powder form)

C, S Analyzer in Metals

Research Area : Chemical Analysis



C and S in metals can simultaneously be determined with this equipment. The equipment is fitted with an induction furnace where the samples are burnt in presence of O_2 . The C and S of the steel are converted to CO_2 and SO_2 , which are measured in the IR Cell.

Equipment Information

Model & Make : Leco CS444, Eltra

Year of Installation : 2000

Applications : C, S analysis in metals

Resolution & Range : 0.1 ppm to 20 ppm

Sample : Solids, Standards for calibration of the equipment should be brought by the users.

Direct Reading Spectrograph (DRS)

Research Area: Chemical Analysis



This is a simultaneous type polychromator Spectrograph with as many as 45 channels with 34 elements. Simultaneously 32 elements can be measured in a sample. Here the sample is sputtered with the spark source and the emission are measured with the help of 45 photomultiplier tube placed against factory cut slit positioned at individual Bragg angle. The configuration of the spectrometer is Pachen-Runge mounting with the Ronald circle giving adequate resolution.

Equipment Information

Model & Make : Bruker Q8 Magellan

Year of Installation : 2009

Applications : Elemental analysis of metals and alloys

Resolution & Range : 1 ppm to 99 %

Sample : Solids

Gas Analyzer in Metals

Research Area : Chemical Analysis



O₂, H₂ and N₂ in metal can be determined by this equipment by fusing the sample in an impulse furnace eluting the O₂ and N₂ present in the sample which is kept in a graphite crucible. Eluted O₂ converts into CO₂ and is measured in an IR Cell. N₂ is determined in a TCD bridge. The equipments are calibrated with known standards before measuring the sample.

Equipment Information

Model & Make : Leco TC 436, HF 402

Year of Installation : 2000

Applications : Gas analysis in metals

Resolution & Range : 0.1 ppm to 20 ppm

Sample : Solids. Standards should be brought by the user for calibration of the equipments

Inductively Coupled Plasma – Optical Emission Spectrometer (ICP-OES)

Research Area : Chemical Analysis



Inductively coupled plasma optical emission spectrometry (ICP-OES), is an analytical technique used for the detection of trace metals (ppb). It is a type of emission spectroscopy that uses the inductively coupled plasma to produce excited atoms and ions that emit electromagnetic radiation at wavelengths characteristic of a particular element. The intensity of this emission is indicative of the concentration of the element within the sample. Unlike atomic absorption spectroscopy, which can only measure a single element at a time ICP-OES has the capability to scan for all elements simultaneously. This allows rapid sample processing.

Equipment Information

Model & Make : Varian/Vista-MPX

Year of Installation: 2005

Applications : Trace elemental analysis in metallurgical and water samples

Resolution & Range : 100 ppb to 1000 ppm

Sample : Sample should be in solution form, Standards will be provided by NML

Inductively Coupled Plasma – Mass Spectrometer (ICP-MS)

Research Area: Chemical Analysis



Inductively coupled plasma mass spectrometry (ICP-MS) is a type of mass spectrometry that is highly sensitive and capable of the determination of a range of metals and several non-metals at concentrations below parts per trillion (ppt). It is based on coupling together an inductively coupled plasma as a method of producing ions (ionization) with a mass spectrometer as a method of separating and detecting the ions. ICP-MS is also capable of monitoring isotopic speciation for the ions of choice. Unlike atomic absorption spectroscopy, which can only measure a single element at a time ICP-MS has the capability to scan for all elements simultaneously. This allows rapid sample processing.

Equipment Information

Model & Make : Perkin-Elmer/Elan DRCe

Year of Installation : 2007

Applications : Trace and ultra trace elemental analysis in metallurgical and water samples

Resolution & Range : 1 ppb to 100 ppm

Sample : Sample should be in solution form, standards will be provided by NML

Proximate Analyzer for Coal

Research Area : 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 : TGA 1000 Navas instrument

Year of Installation : 2014

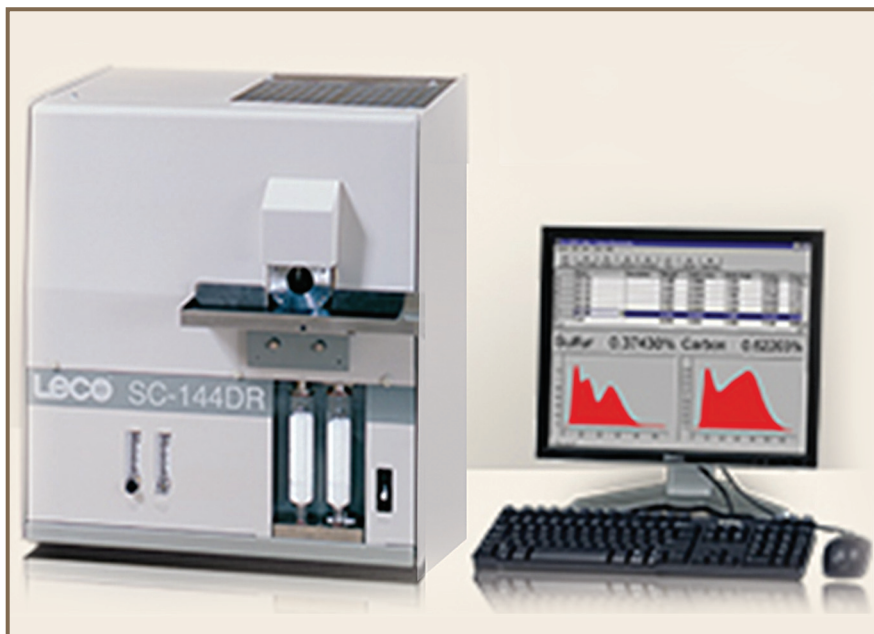
Applications : Coal Analysis

Resolution & Range : Furnace temperature up to 1000 °C

Sample : Solids (0.5g to 1g in powder form)

Sulfur Analyzer for Coal

Research Area : Coal Analysis



Sulfur analyzer is used to determine total sulfur content in coal. Coal is burnt in presence of excess oxygen and the SO_2 gas produced is analyzed using IR detector. The analysis is fast with each sample taking 3 min approximately.

Equipment Information

Model & Make : TGA701, Leco, USA

Year of Installation : 2014

Applications : Coal Analysis

Resolution & Range : Furnace temperature up to 1000°C

Sample : Solids (5 g in powder form)

X-ray Fluorescence Spectrometer (XRF)

Research Area : Chemical Analysis



The primary advantage of X-ray fluorescence (XRF) analysis is that it is independent of the chemical bonding of the elements in the sample. In XRF, the sample is excited with a primary X-ray beam, causing the sample to fluoresce. The primary X-rays eject electrons out of the inner atomic shells (K-and L-shell). The resulting "vacancy" is filled by an electron from an outer atomic shell. This electron transition takes place only between the inner shells of the atom, which are not involved in chemical bonding. Due to the independency of chemical bonding, the samples can be analyzed directly without advanced sample preparation. This makes XRF one of the best methods for elemental analysis.

Equipment Information

Model & Make : Bruker/ S8-Tiger

Year of Installation : 2012

Applications : Elemental analysis of metallurgical samples

Resolution & Range : 10 ppm to 100 %.

Sample : Solids, liquids, powders.
Standards should be brought by the user for calibration of the equipment.



Corrosion and Surface Engineering

Basic Raman Spectrometer

Research Area : Surface Engineering



Raman spectroscopy is a versatile and simple analytical technique for identifying the bonding structure of samples and determining their composition. Using this instrument an unknown substance whether inorganic or organic can be identified by getting its Raman spectra within normal operating range of the microscope and comparing the position of its peaks against a catalogue of Raman spectra of known elements and compounds. The instrument does not need any specific sample preparation or generation of any vacuum/inert atmosphere inside of the sample compartment. By using microscope one can mark the desired location/phases of the sample and direct the laser to fall at the selected point. The instrument equipped with software collects Raman spectra and selected part can be identified by comparing the spectra available in inbuilt library.

Equipment Information

Model & Make : Almega XR, Thermo electron scientific instrument corporation (USA),

Year of Installation : 2005

Applications : Identification of phases/compounds in an unknown sample, Changes in bond structure of a material caused due to any treatment, Quantitative determination of inorganic/organic phases in a sample

Resolution & Range : spectral range : 100 – 4000 cm^{-1} Raman shift

Sample : Solid/ liquid

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_2 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, Quantachrome, USA

Year of Installation :

Applications : Minerals, Porous materials, ceramics, catalysts and adsorbents

Resolution & Range : Minimum surface area: $0.01\text{m}^2/\text{g}$ and Pore size range: 3.5 to $.4000\text{\AA}$

Sample : Inorganic Solid in powder or granular form

Electron Beam Evaporation unit



Electron beam evaporation is used to for coatings single layer and multilayers of metals, alloys, ceramics. It is an atomic deposition PVD process, done by Thermal evaporation where the coating material is melted with the help of electron beam gun. The unit has the capability of 1×10^{-7} mbar. It has 2 electron guns having 4 crucibles in each. The substrate (on which coating is required) has also heating facility up to 700°C .

Equipment Information

Model & Make : HHV, Electron Beam evaporation unit, SN 2237

Year of Installation : 2009

Application : For making the thin-film as well as thick-film, multilayers.

Resolution & Range :

Sample : Flat 5mm-150 mm (square, rectangular or circular)

FTIR Spectrometer System

Research area : Surface Engineering



Instrument is useful in detecting the chemical bond vibration of organic and inorganic materials.

Obtained spectra helps in identifying the chemical nature of the bond and the functional group present qualitatively. Generally operated with KBr palate for powder sample. 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

Year of Installation :

Application :

Resolution & Range : 400-4000 cm^{-1}

Sample : Solid powder, Liquid & gel, Paint, emulsion

Integrated High Power Diode Laser (HPDL)

Research area : Surface engineering/modification



To tailor the surface to achieve enhanced engineering properties such as wear, erosion, cavitation, and corrosion resistance, high power lasers are fast becoming material processing technique. High power diode laser can be used for reclamation or repair of expansive service worn component. It is commonly used for

Surface cladding : Depositing different metal/alloy powder on target components with various clad thicknesses

Surface alloying : Alloying the outer surface with desired metallic elements/ powders

Surface melting : For changing the microstructure of outer surface

Surface hardening : Hardening of the outer surface to different case depth

These processes are industrially useful especially for engine valve, seats, turbine engine, blades, shroud interlock, cutting tools, gears etc.

Equipment Information

Model & Make : ROFIN DL28Q

Year of Installation :

Applications : Surface modification of engine valve, seats, turbine engine, blades, shroud interlock, cutting tools, gears etc.

Resolution & Range :

Sample :

TGA - Cahn Balance

Area Linked to : Surface Engineering



The operating temperature up to 1700°C combined with a sample capacity of 100 grams makes this instrument ideal for analysing ceramics and metal powder injection moulded parts exposed for varying temperature and time. It is a very sensitive instrument for the accurate measurement (in micron level) of change in weight of the materials/components or any large heterogeneous sample per unit time.

Equipment Information

Model & Make : TherMax 700 TGA System, Thermo Fishers Scientific Private India Ltd. (Germany),

Year of Installation : 2009

Applications : To assess the performance of the particular materials exposed at certain temperature and time in certain environment (gaseous).

Resolution & Range :

Resolution/sensitivity of the balance : $\pm 1 \mu\text{g}$

Maximum vacuum : 5×10^{-5} torr

Temperature stability : $\pm 1^\circ\text{C}$

Temperature repeatability : $\pm 3^\circ\text{C}$

Sample : Solid/powder

High Temperature Atomic Force Microscope

Research Area : Characterization of material's surface at various temperatures



High temperature atomic force microscope is used to study the surface morphology using interactive forces between the atoms on the surface and the tips. The system is also known as Scanning Probe Microscope (SPM) and it has the various modes of scanning probes:

Equipment Information

Model & Make : UHV 7500 AFM/STM, RHK, USA

Year of Installation : 2012

Applications : To study materials micro-structure

Resolution & Range : Temperature Range : STM : 90 K to 1500K, AFM : 90 K to 773 K
MFM : 90 K to 500 K, Scanning Range : 1 m, Spatial Resolution : ± 0.01 nm
Z-resolution : ± 0.01 nm, Vacuum : $< 5 \times 10^{-7}$ torr, Sample size : $5 \times 5 \times 0.5$ mm³

Sample : Samples should be flat and it can be Ceramics, Polymers and Metal for AFM mode of operation. Conducting samples are required for STM and magnetic samples are required for MFM mode of operations. 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. Fundamental scientific studies will be encouraged.

High temperature thermal analyzer (TG/DTA)

Research Area : Study of thermal behaviour of materials



High temperature thermal analyzer (TG/DTA) is used to study the changes of materials characteristics such as phase transformation and chemical reactions with temperatures. The system is having the capability to measure the differential thermal behaviour of solid and liquid samples with respect to standard reference material using DTA and simultaneously measure any changes in mass using TG.

Equipment Information

Model & Make : LINSEIS GmbH, Germany

Year of Installation : 2009

Applications : To study phase transformation and chemical reactions in various temperatures.

Resolution & Range :

Temperature Range : RT -1700°C

Temperature Measurement Accuracy : $\pm 1^{\circ}\text{C}$

TG Range : $\pm 0.1\text{ gm}$

TG Sensitivity : $\pm 0.2\text{ }\mu\text{gm}$

DTA Range : $\pm 1000\text{ }\mu\text{V}$

DTA Sensitivity : $\pm 0.1\text{ }\mu\text{V}$

Sample : Samples can be Ceramics, Polymers and Metal, which should not react with the Alumina crucibles. The materials should not be toxic in nature and should not generate any toxic gases during thermal cycle. Nuclear materials and hazardous chemical will not be used in this system.

Humidity Test Chamber

Research Area : Surface Engineering

An environmental test chamber artificially replicates the conditions under which machinery, materials, devices or components might be exposed. It is also used to accelerate the effects of exposure to the environment, sometimes at conditions not actually expected. These conditions may include: extreme temperatures, sudden and extreme temperature variations, moisture or relative humidity, electrodynamic vibrations, electromagnetic radiation, salt spray, rain; weathering, exposure to sun, causing UV degradation and vacuum. The humidity testing determines how components, subsystems and complete systems behave in severe environments that involve elevated temperatures and high or fluctuating relative humidity. The tests can be static with constant temperature and humidity, they can involve the cycling of both, and they can be temperature-humidity bias tests (where the moisture is used to induce a failure in an electrical device) or some combination of all of these.



Equipment Information

Model & Make : WK1/340/40 WEISS

Year of Installation : 2003

Applications : environmental test chambers are able to provide rapid product temperature change rates and use varying levels of relative humidity to locate design problems prior to shipping your products, improving product quality and reliability.

Resolution & Range :

Temperature range : -40/+180°C

Humidity range : 10-95% rh

Dew point : 4-95°C

Sample : Solid/Powders

Image Analyser

Research Area : Surface Engineering

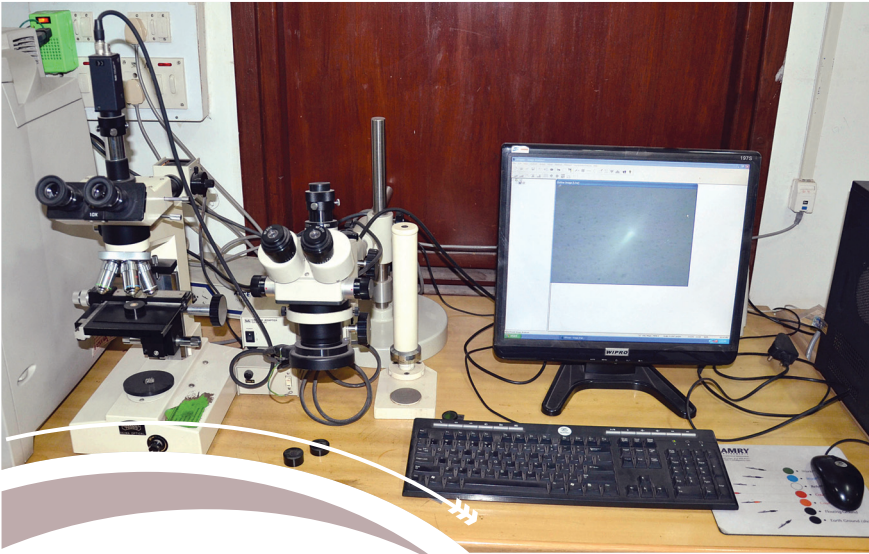


Image analyser is a versatile and simple imaging technique for identifying the macro/micro structure of metallurgical samples. By using microscope one can mark the desired location / phases of the sample and direct the light to fall at the selected point. The instrument equipped with software to identify various phases, grain size measurement, by Heyn intercept and Jeffries planimetry method (ASTM - E112 / E1382-91) | Austenitic grain size measurement Phase analysis (Percentage, volume and Area Fraction) and distribution of phases (ASTM - E-562) Linear Measurements like plating, coating, decarburization, banding etc. Nodule count (% Modularity Analysis), Distribution, nodule classification etc.(ASTM E 247). Graphite Flake analysis for size class and separation of A, C, D, E flakes and their exact % estimation (ASTM A-247-67) Inclusion Analysis (ASTM E 45/ E 1122) separation and rating Dendritic arm spacing Porosity measurement (size and distribution analysis) with particle count & size analysis Image database management software.

Equipment Information

Model & Make : SEIWA, JAPAN

Year of Installation : 2004

Applications : It is used to assess the structure of the materials and to examine for metallurgical anomalies such as third phase precipitates, excessive grain growth. For macro and micro, case depth, weld examinations; decarburization measurement, coating plating evaluation, surface evaluation and grain size measurement.

Resolution & Range : Macro-1-4.5x and micro-10-100x

Sample : Solid/ Powders

Mercury Porosimeter

Research Area : Evaluation of porosity in materials



Mercury Porosimeter is used to evaluate the porosities in samples, which can be metals and ceramics or composites in the form of either solid compact (sintered/unsintered) or in powder form.

Equipment Information

Model & Make : PMI 60K – A-I, M/s PMI, USA

Year of Installation : 2011

Applications : To evaluate the porosities in samples

Resolution & Range :

Pressure Range : 0–6000 PSI

Pore Diameter Range : 3.5 nm to 500 m

Vacuum Guage : 0 to 10^{-3} torr

Sample Volume : 0.5 cc to 2 C. C.

Sample : Samples can be Ceramics, Polymers and Metals, which should not be toxic in nature and it should not generate toxic gases during analyses. Nuclear materials and hazardous chemicals will not be used in this system.

Microhardness Tester



Microhardness unit is equipped with Vickers and knoop indenter. The load capacity is from 1gm to 2000 gm in discrete increments. It is used for measurement of static hardness of different phase in the materials and coatings.

Equipment Information

Model & Make : Leica VMHT Auto

Year of Installation : 2004

Application : Microhardness is used for measurement of Hardness, young modulus, Fracture toughness, creep, load displacement curve. This is applicable for mechanical properties of surfaces, coatings, multiphase materials.

Resolution & Range : 1g-2000g, eyepiece: 10 X, 50x, 100 X

Sample : Thin-films coatings, Bulk solid materials.

Multi Target RF/DC Magnetron Sputtering System



The magnetron sputtering can be used for coatings 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 1×10^{-6} mbar. It has 3 magnetron source with substrate holder having substrate heating and biasing facility up to 700°C and 200V respectively.

Equipment Information

Model & Make : HHV, Multitarget RF/DC sputtering unit, SN 2178

Year of installation : 2008

Application : coatings single layer and multilayers of metals, alloys, ceramics, composites.

Resolution & Range :

Temperature : 700°C

Biasing voltage : 200V

Pressure : 1×10^{-6} mbar.

Sample : Flat 1mm-80mm (square, rectangular or circular)

Nanoindentation Unit



Description: This XP naniondenter works in continuous stiffness measurement (CSM) and control load mode. Berkovich indenter is mainly used for determination of mechanical properties and elastic plastic behaviour of material. 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'

Year of installation :

Application : Nanoindentation is a method of measurement of the mechanical properties of small volume of material as Hardness, young modulus, Fracture toughness, creep, load displacement curve. This is applicable for 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-films coatings, Bulk solid materials.

Pin-on-disc Wear Tester

Research Area : Tribological behaviour of materials



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 to measure 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

Resolution & Range :

Sample Size : 50 mm dia x 6 mm thick

Pin Size : 2×2 to $4 \times 4 \text{ mm}^2$

Test Load : 0.2N to 2 N

Standard : ASTM G 99

Sample : Samples should be flat and it 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.

Pulsed Plasma Ion Nitriding (PPIN)

Research Area : Surface Engineering



Pulsed plasma ion nitriding (PPIN) is used to modify the surface of steel components through 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 brittle white layer thus, reducing 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 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 upto 600°C,

Frequency : Variable from 1 to 30 kHz,

Voltage : 600V,

Duty Cycle : Variable

Sample : Metal components, sheets etc.

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 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 include colour change, gloss loss, chalking, cracking, crazing, hazing, blistering, embitterment, strength loss and oxidation by sunlight and dew.

Resolution & Range :

Sample : Painted/Coated samples

Salt Spray Test Chamber

Research Area : Surface Engineering



The salt spray test is a standardized test method used to check 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 to the coated samples in order to predict its suitability in 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 on exposure to corrosive environment.

Resolution & Range :

Sample : Painted/Coated /uncoated samples

Scratch Tester



Indenter drags on the surface of the sample with different load. By using the traction force and normal load one can find the coefficient of friction. 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 20-200N, 1-20N

Sample : Any flat smooth surface.

Surface Profilometer



Profilometer works on the principle of LVDT (Linear Variable Differential Transform) here stylus is dragged on surface of sample which gives roughness and profile of the surface. It can also measure the thickness of the coatings if some area is masked during the coating so that uncoated area is having sharp boundary.

Equipment Information

Model : Taylor hobson, form Taly surf series 2.

Year of Installation : 2005

Application : For measuring the thickness and roughness of the surface.

Resolution & Range : 15 nm, 0-200 μm

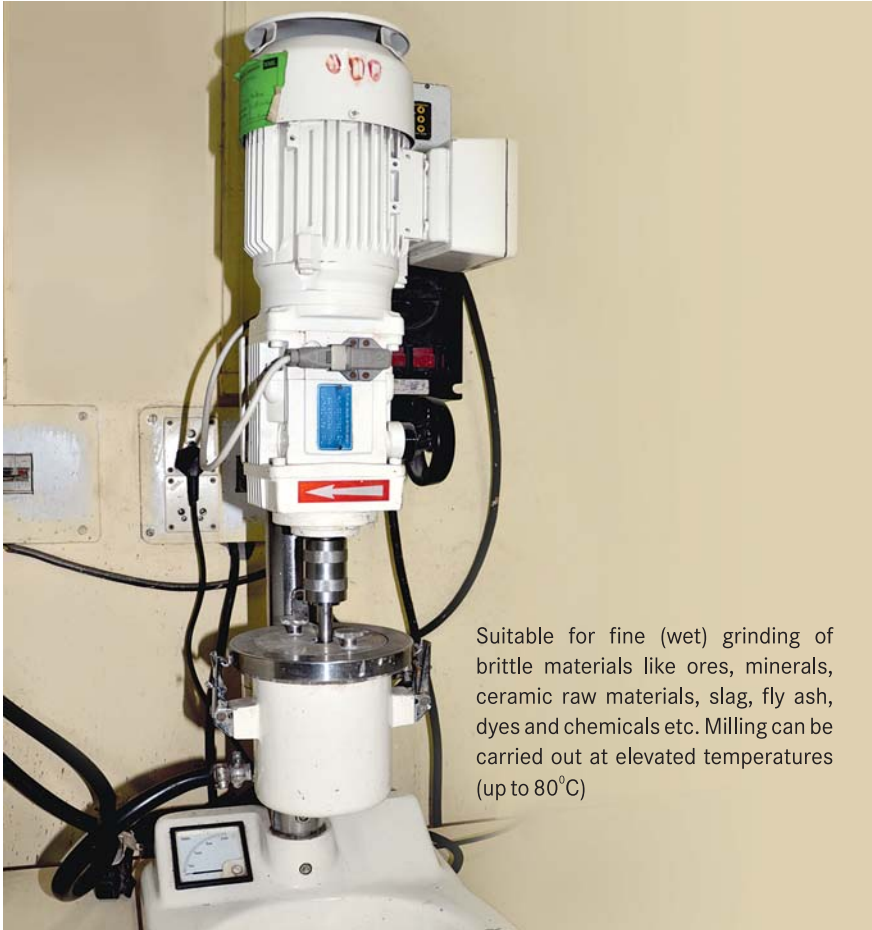
Sample : Any flat and curved surface less than 300 micrometer finish/surface undulations., 5mm-100 mm



Materials Extraction and Forming

Attrition mill

Research Area : Fine Milling/Mechanical Activation



Equipment Information

Model & Make : Model : PE075

Year of Installation : 2001

Applications : fine grinding, mechanical activation

Resolution & Range :

Sample : Feed size upto 150 micron

Attrition mill

Research Area : Fine Milling/Mechanical Activation



It is continuous type attrition mill and can be used for fine (wet) grinding of brittle materials such as ores, ceramic raw materials, slag, fly ash, dyes and chemicals

Equipment Information

Model & Make : Labstar, Netzsch, Germany

Year of Installation : 2004

Applications : fine grinding, mechanical activation

Resolution & Range :

Sample : Feed size upto 150 microns

Surface Area and Porosimetry Analyzer

Research Area : Surface Characterization



Surface area and pore size distributions are important properties that determine reactivity of solids. The Accelerated Surface Area and Porosimetry Analyzer (Model ASAP2020: Micromeritics Instrument Corporation, USA) can measure surface area and pore size distribution of powder samples of metal, ceramic, ores etc using nitrogen adsorption.

The equipment can be used to measure specific surface area from as low as 0.01 m²/g for powdered glass, glass fibres etc to >1000 m²/g for very high surface

area materials such as MCM41 etc. Isotherm, single point BET surface area and multipoint BET (and/or Langmuir) surface area report and plot can be obtained.

Pore size analysis : Porosity and pore size distribution can be measured for pores in the range 3.5-5000Angstrom. Complete isotherm comprising the adsorption and desorption, BET (and/or Langmuir) surface area report and plot, total pore volume, t-plot micropore analysis, BJH pore distribution analysis (based on adsorption and/or desorption data) reports and plots can be obtained. A 5-10 g of solid sample is required for measurement. Measurement time may vary between a 2-4 hours for specific surface area analysis and up to 24 h or more, depending on the nature of the sample, for pore size analysis.

Equipment Information

Model & Make : Model ASAP2020: Micromeritics Instrument Corporation, USA

Year of Installation : 2006

Applications : Surface area and pore size analysis

Resolution & Range : 0.01-1000 m²/g

Sample : Powder/granules (upto 1 mm)

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

Resolution & Range :

Sample : Brittle materials upto 20 mm size

Zeta Probe Analyser

Research Area : Surface Characterization



Zeta probe (Make: Colloidal Dynamics USA) is used for measuring zeta potential of particles which is an extremely important parameter across a wide range of industries including brewing, ceramics, pharmaceuticals, medicine, mineral processing and water treatment. It gives a measure of the stability of the colloidal system. Its measurement brings detailed insight into the dispersion mechanism and is the key to electrostatic dispersion control.

This equipment measures the zeta potential in colloidal suspensions and emulsions. The equipment works on multi-frequency electro acoustic method. Its automatic titration facility facilitates determination of isoelectric point. It has provision for correction for particle size and double layer distortion.

Data can be made available in MS Excel format contains zeta potential, dynamic mobility, conductivity, pH, temperature and isoelectric point.

Equipment Information

Model & Make : Zeta Probe, Colloidal Dynamics USA

Year of Installation : 2006

Applications : zeta potential, isoelectric point

Resolution & Range :

Sample : powder sample, ~ 45 microns

Thermal Conductivity Tester

Research Area : Materials Characterization



Thermal conductivity is the most important thermo physical parameters for characterization of the thermal transport properties of a material or component, specially 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(R) 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 heat source and 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. Controller unit is connected with measuring frame inside a SiC Thermocouple bearing furnace. With this instrument Thermal conductivity of refractories can be measured at room temperature as well as high temperature. (1500°C)

Equipment Information

Model & Make: TCT-426 & NETZSCH

Year of Installation :

Applications: Thermal Conductivity measurement of Refractories

Resolution & Range : Range - RT to 1500oC

Sample : Refractory brick, size- 230x115x65 mm

Forging Hammers

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

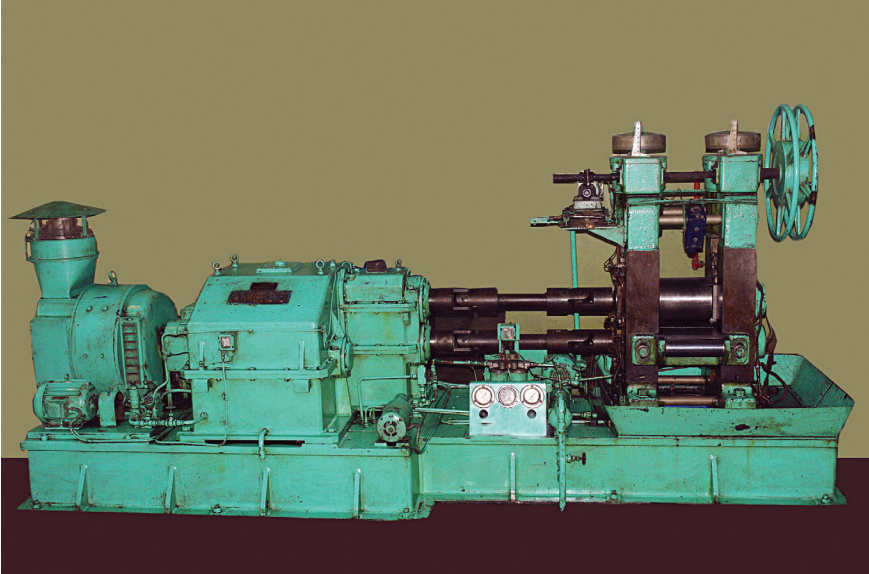
Applications : Open die forging

Resolution & Range : 10CWT, hammer speed 110,
Flywheel speed 544, HP 60(max)

Sample :

Rolling Mills

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 10in. face rolls made of special harden forged steel to with stand hot or cold rolling. Maxim roll gap is 50mm.

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 3.5in. & 18in. diameter X 20 in. face rolls. The capacity of machine is 100 ton. Maxim roll gap is 50mm.

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

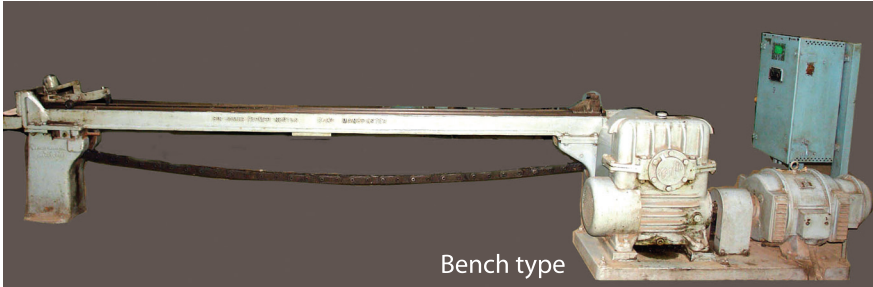
Applications : Rolling ferrous as well as non ferrous materials

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)

Sample :

Wire Drawing Machines

Research Area : Metal Forming



Bench type



Drum type

Bench type and Drum type wire drawing machines are used for drawing ferrous as well as nonferrous materials. In the present setup, wire up to 0.3mm 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 0.315mm or 30SWG

Sample :

Down-draft sinter pot

Research Area : Pyrometallurgy



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

Equipment Information

Model & Make : Local vendor

Year of Installation : 2010

Applications :

Resolution & Range : Capacity : 10-12kg/ batch for iron ore mix

Sample : Fines and micro-pellets of ores

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

Model & Make :

Year of Installation : 2006

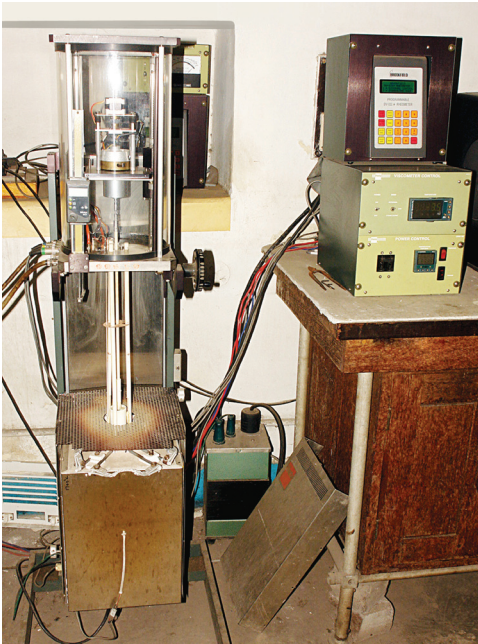
Applications :

Resolution & Range :

Sample : lump iron ore, pellet, sinter and briquettes

High Temperature Viscometer

Research Area : Pyrometallurgy



Evaluation of thermo-physical properties of an industrial system is more important to decide the quality of 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 product. Among all these properties, viscosity, softening/melting temperature of molten slag/metal/ mold powder plays a vital role at high temperature. Viscosity of fluids varies with temperature due to their change in crystal structure. Viscosity of slag/metal/mould powder/flux/alloys is measured at different temperatures in the viscometer to determine the softening melting behaviour of the

given material. Viscometer is completely controlled through 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.

Principal of measurement : Rotating bob method

Equipment Information

Model & Make : Brookfield LV DV- III+ & Theta Scientific-USA

Year of Installation : 2003

Applications :

Resolution & Range :

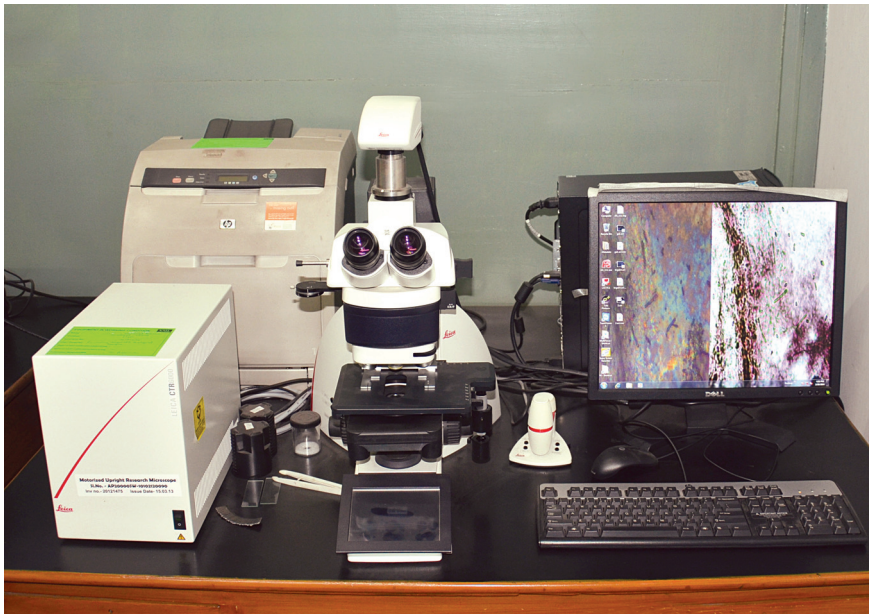
Temperature range : from ambient to 1550°C

Viscosity range : upto 5x10E5 cP (centiPoise)

Sample : molten metal, slag, flux, glass, oil & coal ash

Motorized Biological-cum-Materials Research Microscope

Research Area : Materials, Alloy and Biological characterization



This material-cum-biological integrated microscope is first of its unique facility installed in India by Leica at CSIR-NML, which can help the user to view, identify, and characterize the samples like, materials, powders, alloys, coatings, microbial cells and its 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 very ideal for metallurgical and biological samples viewing under polarized and differential interference suites. For biological samples, the microscope shall serve 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.

contd....

Motorized Biological-cum-Materials Research Microscope

Equipment Information

Model & Make : M/s LEICA, Germany

Year of Installation : 2012

Applications :

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 5mm and thickness ~5mm. Powder samples of any type are also suitable. Can sectionally view the samples across Z-axis, suitable for some uniquely shaped specimens Powder samples don't have a mandatory precaution of polishing, though it will be advantageous in that mode. In-situ experiments can be viewed at microscale and recorded. A image of incident and transmitted light can be overlaid for greater details.

GLEEBLE® 3800 Thermo-mechanical Simulation System

Research Area : Materials processing and physical simulation



The thermo-mechanical/physical simulation is one of the most important aspects in the development of materials processing methodology. This involves exact reproduction of the thermal and mechanical processes employed in actual component fabrication. The GLEEBLE thermo-mechanical simulation system is a dynamic testing machine that can be used for the simulation of a wide variety of metallurgical processes such as single and multi-pass rolling, extrusion, forging, continuous casting, hot tensile and compressive testing, HAZ in welding, thin strip annealing etc. In addition, the system can be effectively used for hot ductility testing, hot/warm compressive and tensile testing, SICO test, thermal cycling/heat treatment simulations and dilatometry/phase transformation (CCT) studies. The system uses direct resistance heating of the sample and, therefore, avoids the use of a furnaces and inaccuracies involved thereof. A closed-loop hydraulic servo system provides precise control of all mechanical variables. The system can operate in the range from room temperature to 1700 °C. The thermocouple data acquisition rate can be varied, with a resolution of 1°C, depending upon the requirements. Typically, a sample of material is heated and mechanically worked while various performance parameters of interest are measured and recorded for later analysis. After the simulation or test is done, the microstructure of the material may be examined and analyzed to see the effects of the process schedule adopted.

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GLEEBLE[®] 3800

Thermo-mechanical Simulation System

Equipment information

Model and make : GLEEBLE 3800 and Dynamic Systems Inc. (USA)

Year of Installation :

Applications : Process simulation (Rolling, forging, extrusion, continuous casting, strip annealing, weld HAZ, thermal cycle/heat treatment) and Materials testing (Hot/warm compressive and tensile testing, Nil strength, hot ductility, phase transformation)

Resolution & Range : Temperature (RT to 1700 °C; 1°C); Load (20 T in compression and 10 T in tension); Heating rate (Max. ~ 10,000 °C/s; sample size dependent)

Sample : Depends on the tests to be carried out and can be provided on demand

Electroslag Refining Unit (ESR)

Research Area : Process Metallurgy



Advantages of ESR Process

1. Control of chemical composition and its homogeneity
2. Removal of micro-and macro-segregation
3. Removal of S and P in desired level
4. Sound ingot with no porosity, blow hole, pipe, etc
5. Increase of UTS, YS, ductility and toughness
6. Increase of weldability
7. Increase of formability
8. Control of microstructures

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 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 purification of the metal from oxygen and non-metallic inclusions resulting 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 higher purity and better structure of high-alloyed steels produced by electroslag refining their deformability and weldability are also improved.

Equipment Information

Model & Make: Indigenous with fully auto control DC power source

Year of Installation :

Applications: Removal of non-metallic inclusions and sulphur content of alloy steel and non-ferrous metal.

Resolution & Range :

Sample : 40 mm diameter electrode of length ~ 1000-2000 mm.

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.

Year of Installation :

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

Submerged Arc Furnace

Research Area : Pyrometallurgy



The Battery of Submerged arc furnace at CSIR-NML consists of 50 kVA, 150kVA and 500kVA units. These facilities are employed to study smelting reduction behaviour of a variety of raw materials including lean grade ores, waste materials, DRI, 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 techno- economical feasibility of a process. The data generated in these furnaces are directly used for commercial production.

Equipment Information

Model & Make :

Year of Installation :

Applications :

Resolution & Range :

Sample :

Induction Melting Facilities

Research Area : Pyrometallurgy



CSIR-NML has an excellent array of induction furnaces to produce/ develop speciality alloy. These array includes air induction furnaces of 5 to 20 Kg capacity and vacuum induction furnaces 5 to 40 Kg capacity, equipped with alloy addition and tapping under vacuum. These furnaces can be used for the development of clean alloy development of ferrous, Non-ferrous and inter metallic's. 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 and casting under vacuum.

Equipment Information

Model & Make : Inductotherm

Year of Installation :

Applications : These furnaces can be used for alloy development.

Resolution & Range :

Sample : Ferrous and Nonferrous alloys

High Pressure Reactors

Research Area : Process Metallurgy



To carry out 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 Pressure Reactors

Equipment Information

Model & Make :

Year of Installation :

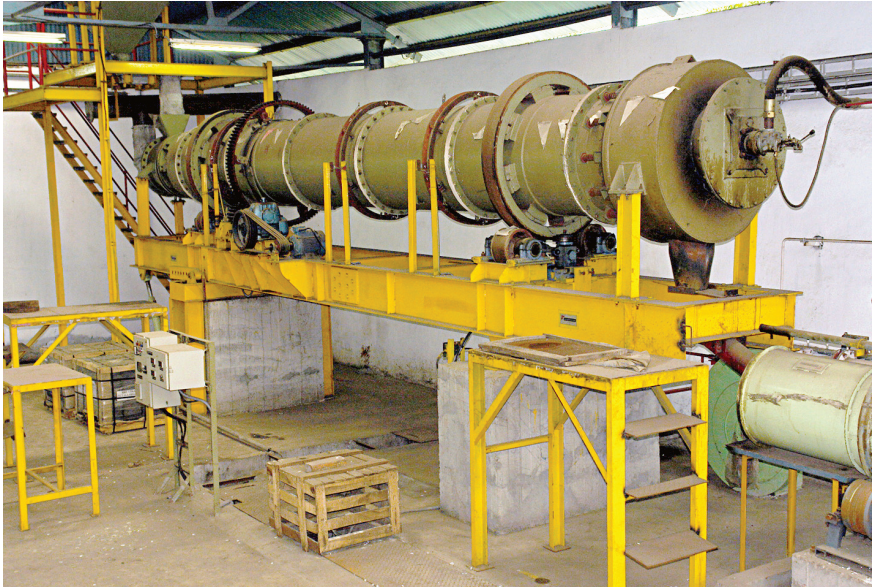
Applications : Dissolution and precipitation reactions at high temperature and pressure conditions under different atmosphere (reducing, oxidizing and inert).

Resolution & Range :

Sample : Powder sample

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

Model & Make :

Year of Installation : 2005

Applications :

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 location along length by means of S type (Pt-Pt/Rh) thermocouple with sensors & Transmitter to Digital Temperature Indicator

Sample :

High Temperature Fluidized Bed reactor

Research Area : Process Metallurgy



The high temperature fluidized bed reactor is a sophisticated pilot unit for experimental studies of reactions involving reduction of ores to metallic state using gases like CO and LPG and neutral gases like N_2 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 totalized. The outflow may be sampled and separately analysed. 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 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 over pressure in gas lines is achieved by using special safety valves that have adjustable trip points at present 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 double walled water cooled housing with two thermocouples for temperature monitoring and a viewing window for observation. This window has tempered glass.

Equipment Information

Model & Make : Montech Instruments, Chandigarh

Year of Installation :

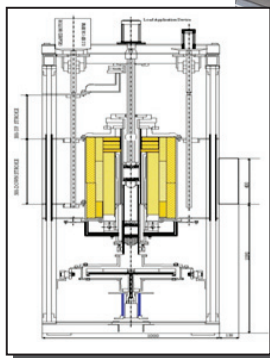
Applications : To study the reduction of ores to metallic state using gases like CO and LPG and neutral gases like N_2 and argon.

Resolution & Range : Upto $1200^{\circ}C$

Sample type : Solid materials

High Temperature Softening-Melting (HTSM)

Research Area : Process Metallurgy



The softening-meltdown properties of ferruginous material have 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 prior to their use in the blast furnace. The HTSM equipment tests the ferruginous raw material in the laboratory under blast furnace simulated conditions and the parameters those can be calculated/ inferred by the test are softening temperature (T_s), melt down temperature (T_m), resistance to gas flow, bed shrinkage and % Non-dripped material (NDM)

Equipment Information

Model & Make : Indigenous Con Com Consultants, Ranchi

Year of Installation :

Applications :

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 lpm ($30\% \text{CO} + \text{H}_2 + \text{N}_2$), CO_2 if needed and rest N_2

Gas flow regulation indication - Mass flow controller

Top Pressure - Up to 2 Kg/cm^2

Sample : Solid materials

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. The 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 mixer settler unit. The regenerated organic is recycled in the system for the subsequent operation. It can be operated in closed loop of electrolytic cell of 9-10 L lab scale or 100 L and 600 L at pilot scale.

Equipment Information

Model & Make :

Year of Installation :

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.

Resolution & Range :

Sample :

Aqueous Electrolysis set up with rectifier

Research Area : Process Metallurgy



The electro-winning (EW) cell with rectifier is used for producing metal from the purified aqueous solutions. The cell consists of lead-antimony anode and titanium/ stainless as cathode. The flow of the liquid is maintained with suitable pumps. The metal is deposited on cathode by passing DC current through a rectifier. The EW cells can be operated with variable capacity to produce metal as per requirement.

Equipment Information

Model & Make :

Year of Installation :

Applications :

Resolution & Range :

Sample :

Nanotribometer

Research Area : Materials Processing



Nanotribometer is one of the most important tools for evaluation of nano-tribological properties (nano-wear and nano-scratch) of bulk materials, thin films, melt spun ribbons and conventional materials of metallic and non-metallic compositions.

The system is capable of measuring nanotribological parameters from linear reciprocating tests and Rotational tests. Tests should be possible with pins and balls of miniature dimensions, with loads and displacements measured in the relevant range with nano- to micro- resolution. For Linear reciprocating module stroke length is up to 75 mm and for rotation module the Speed varies from 10 to 1000 rpm, clockwise, counter clockwise, cyclic and gyratic motions. The test types are Ball-on-test specimen or Pin-on-test specimen. The force measurement range is 50 μN to 0.5 N with force measurement resolution 5 μN and also 0.1 to 10 N with force measurement resolution 0.5 mN. The Frictional force measurement resolution is 10 μN . The wear depth can be measured up to 200 μm measurable wear with linear Resolution 25 nm and for 2 mm or more measurable wear the linear resolution is 0.5 μm . High magnification optical microscope is attached to view the sample and wear track without removing sample. The system is also attached with profilometer (DEKTAK-XT) for wear profile measurement.

Equipment information

Model and make : Nano Tribometer (UMT-2), CERT (USA)

Year of Installation :

Applications : Evaluation of nano-wear and nano scratches of thin films, coating, thin ribbons and other bulk samples.

Resolution & Range : Load : 50 μN to 0.5 N with force measurement resolution 5 μN and 0.1 to 10 N with force measurement resolution 0.5 mN. Stroke length: up to 75 mm and for rotational speed 10 to 1000 rpm.

Sample : Depends on the tests to be carried out and can be provided on demand

Microhardness Tester with High resolution camera

Research Area : Materials Processing



Microhardness unit is used for determining micro-hardness of metallic materials including thin foils, rapidly solidified ribbons. The machine is equipped with Vickers and knoop indenter. The load capacity is from 1g to 1000 gm in discrete increments.

Equipment information

Model and make : Auto-Microhardness tester, Omnitech, Pune

Year of Installation :

Application : Microhardness is used for measurement of Hardness, young modulus, fracture toughness.

Resolution & Range : 1g-1000g, (1, 5, 10, 20 or 25, 50, 100, 200, 300, 1000 g), eyepiece : 10 X, 50x, 100 X, 200X, 400X .

Sample : Bulk materials, thin films, ribbons.

Air Jet Erosion Tester

Research Area : Materials Processing



The TR 471-M3 Air jet Erosion tester may be used for performing erosion test by solid particles 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.

Air jet erosion testing unit is used for determining 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.

Equipment information

Model and make : TR 471-M3, made: Ducom, Bangalore India

Year of Installation :

Applications : Evaluation of Erosion resistance of materials

Resolution & Range :

Process Parameters : Angle of incidence: 15, 30, 45, 60 and 75°,
Erodent: Al_2O_3 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: upto 4 hrs

Sample : 25 X 25 X 3 mm

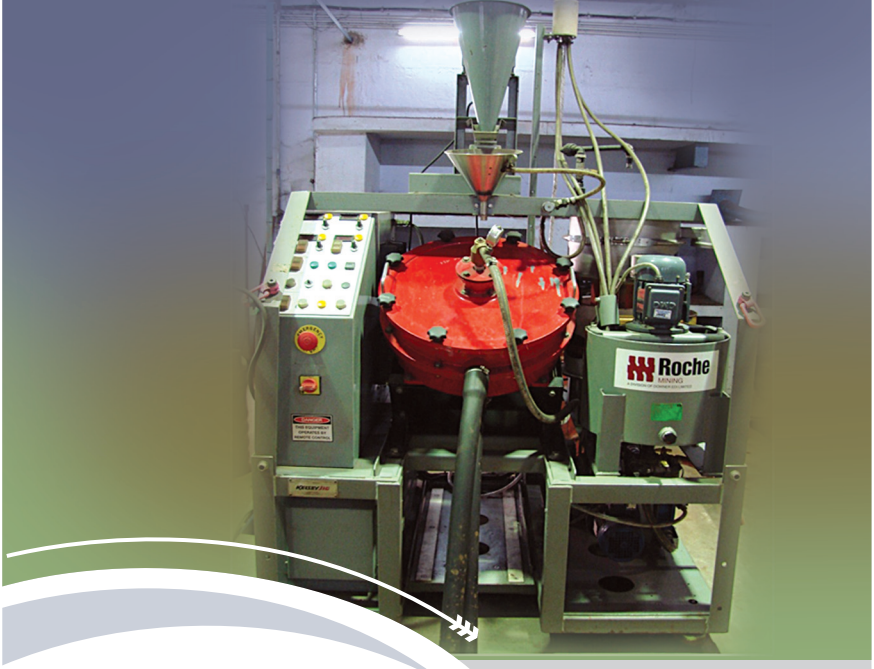


Mineral Processing



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

Applications :

Resolution & Range : g-force upto 100 times

Sample : Particle size < 500 micron

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

Applications :

Resolution & Range : 200 kg/hr

Sample : 40-100 mm

Zetasizer

Research Area : Surface Chemistry



The zetasizer can determine zeta potential of mineral suspension and also the particle size distribution of mineral suspension of particle size below 10 μm . DelsaNano C is a new generation of instruments that use photon correlation spectroscopy (PCS), which determines particle size by measuring the rate of fluctuations in laser light intensity scattered by particles as they diffuse through a fluid, for size analysis measurements and/or electrophoretic light scattering (ELS), which determines electrophoretic movement of charged particles under an applied electric field from the Doppler shift of scattered light, for zeta potential determination. This instrument has an advantage of determining iso-electric-point (iep) of minerals suspension by using an autotitrator wherein the zeta potential is plotted against pH of the medium of the suspension.

Equipment Information

Model & Make : DelsaNano C & Beckman Coulter

Year of Installation : 2009

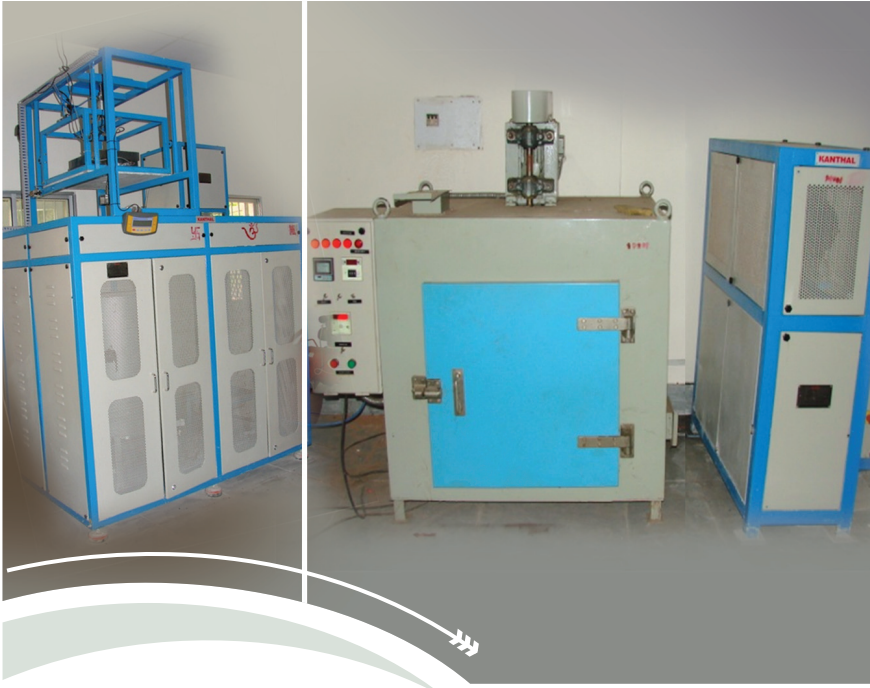
Applications :

Resolution & Range : Particle size : 7 μm down to 1 nm, Zeta potential Particle size : Below 25 μm ,

Sample : Fine/ground mineral sample(-25 μm), slurry samples, colloidal suspension etc.

CRI-CSR Equipment

Research Area : Coke characterisation



The equipment measures (i) Coke Reactivity Index (CRI) and (ii) Coke Strength after Reaction (CSR) indicative of performance of coke in Blast furnace. 200g of sample is heated with CO₂ at 1100°C in a retort followed by tumbling. The percentage of mass loss gives CRI and percentage of +10mm 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 characterisation

Resolution & Range :

Sample : Coke of size -21+19mm or as per IS and ASTM norm

Dual system of Plastometer and Dilatometer

Research Area : Coal characterisation



The equipment measures plastic and dilatation property 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 application of coal in carbonisation, gasification, liquefaction and combustion.

Equipment Information

Model & Make : Plastometer model-PL2000, Dilatometer model- DI4000, M/s R.B. Automazione S.R.L.

Year of Installation : 2013

Applications : Characterisation of plasticity and dilatation property of coal

Resolution Range : Range of Plastometer 0.2-10000 DDPM,

Sample : Coal of size -40mesh to +70mesh for plastometer, and -72mesh for Dilatometer

Optical Petrological Microscope

Research Area : Mineral Characterisation



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

Applications :

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, QWIN image analysis and LAS software.

Sample : Polished mounts and thin section slides

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 of fine 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

Applications :

Resolution & Range :

Ring diameter : 500 mm

Feed particle size : Below 1 mm

Background field : 1 T

Capacity : 30-125 kg/h

Sample :

Coal Petrographic Optical Microscope

Research Area : Coal Characterisation



It is most advance 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 mode. Through this, we can have images up to 500 magnification and measure the reflectance/rank of coal macerals as well as can have modal counting of macerals and mineral matter on visual basis.

It has Petrog automatic point counting device for maceral analysis and QWIN software for image grabbing, enhancement as well as storage at different scales. Coloured photographic camera attached with this microscope facilitates 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

Applications :

Resolution & Range : It is equipped with high resolution lenses/objectives, photometers, fluorescence attachment, QWIN image analysis software & Petrog Softwares.

Sample : Particle size ~ 1 mm size

Falcon Concentrator

Research Area : Mineral Beneficiation



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 200g 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 particle form a bed of particle just adjacent to the wall of the bowl and lighter particle layer remain at the furthest site from the wall. Weak parallel force component helps in migration of layers in upward direction. 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 of fine grain mineral valuables lost in the tailings.

Equipment Information

Model & Make : SB 40, M/s FALCON CONCENTRATORS INC, CANADA

Year of Installation : 2007

Applications :

Resolution & Range :

G force range : upto 200g

Sample : Solid ore sample

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 phosphated 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 serrated profile which promotes high field intensity and gradient. Field strengths upto 2 Tesla are attainable in the gap between feed pole and roll. Non-magnetic particles are thrown off the roll into the tailing compartment, whereas the magnetic are gripped, carried out of the influence of the field and deposited into the magnetics compartment. 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.

Equipment Information

Model & Make : RL9011, Reading, M/s Mineral Technologies, Australia

Year of Installation : 2013

Applications :

Resolution & Range :

Magnetic Intensity Range : 2Tesla (20,000Gauss)

Size Range : -1mm to 0.075mm.

Sample : Dry sand or ore fines

Advanced Flotation Cell

Research Area : Mineral Beneficiation



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.

Equipment Information

Model & Make : FC, M/s Insmart, Hyderabad

Year of Installation : 2014

Applications :

Resolution & Range :

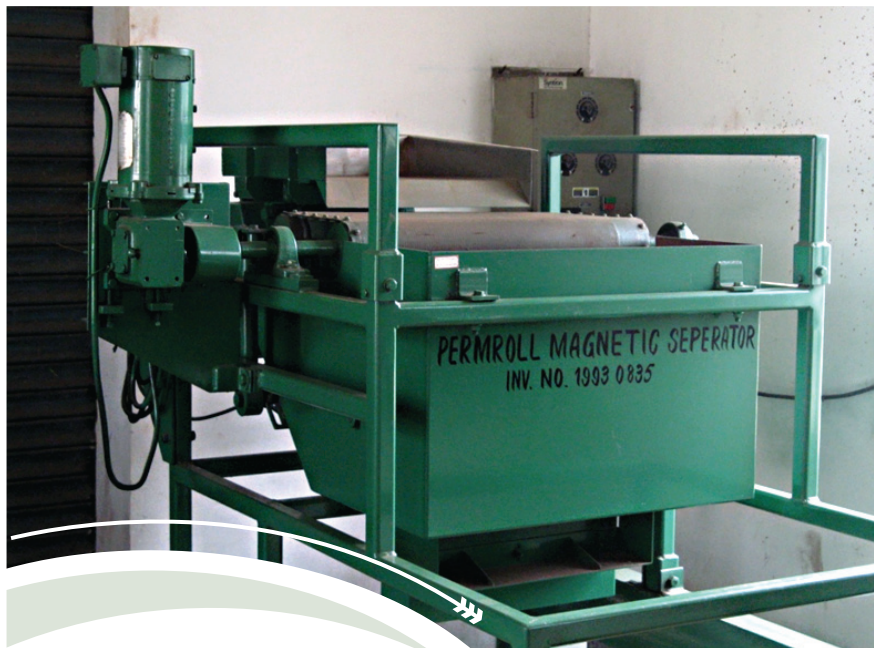
Mode of operation : Batch type

Particle size : -500+10 microns

Sample : Solid ore or fines

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

Applications :

Resolution & Range :

Capacity : 100 kg/hr

Feed size : -30mm +1mm

Sample type : Dry solid sample

High Tension Separator

Research Area : Mineral Beneficiation



High tension separation utilises 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 processing of beach sand, recovery of metallic components from electronic waste and other minerals.

Equipment Information

Model & Make : Carpco Inc, USA

Year of Installation : 1991

Applications :

Resolution & Range :

Sample : The sample should be dried and screened to remove - 75 μm . If the sample has wide size range, then it has to be classified into closed size range.

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 (FM1), MD Mineral Technologies, Australia

Year of Installation : 2007

Applications :

Resolution & Range :

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

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.

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.)

Equipment Information

Model & Make : M/s Turnkey Engineers, Kolkata

Year of Installation: 2008

Applications :

Resolution & Range :

Capacity : up to 300 kg/hr

Particle Size : Particles 1 mm – 0.01 mm feed size

Sample : Coal, iron ore, wolframite, beach sand heavy minerals

Laboratory Instrumented Jig

Research Area : Mineral Beneficiation



The standalone pneumatically controlled laboratory instrumented jig is intended for 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 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 jiggling air which acts on the water perpendicular to the direction of its transit from bottom of the jiggling bed.

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 heaviest materials in the lower-most layers as opposed to the concentration of the lightest 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.

Equipment Information

Model & Make : M/s MBE Coal & Mineral Technology GmbH, Germany

Year of Installation : 2013

Applications :

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

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

Applications :

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

Laser Diffraction Particle Size Analyser with Wet Dispersion and Dry Dispersion System

Research Area : Particle characterisation



Laser diffraction Particle size Analyser consists of wet dispersion system Hydro2000MU built-in recirculation pump, ultrasonic probe, mechanical stirrer, dry dispersion system Sirocco2000 and an application software. It works with the optical principle of laser diffraction and laser scattering, and provides the particle size distribution in volume percent. The d_{10} , d_{50} and d_{90} indicating the size of particles present below 10%, 50% and 90% respectively in an analysis is computed by the software. Software provision exists to exhibit particle size distribution against a size scale in ASTM mesh size, Phi scale and micron.

Equipment Information

Model & Make : MASTERSIZER2000 part No. APA5007, Malvern make

Year of Installation : 2010

Applications :

Resolution & Range : Range of 0.02-2000 micron

Sample : ores, minerals, coal, materials insoluble in water, powder of size < 1500 micron

Mercury Porosimeter

Research Area : Mineral/Material characterisation



The Mercury porosimeter consists of two modules PA-140 and PA-440 for measurement of macroporosity and microporosity respectively, the data being subsequently merged by the software to integrate to a total porosity. It works with the principle of mercury intrusion porosimetry. It measures total porosity of open pores, their pore-type and pore size distribution.

Equipment Information

Model & Make : PASCAL 140/440, ThermoFisher Scientific

Year of Installation : 2003

Applications :

Resolution & Range : Pore size of 0.05 micron to 500 micron

Sample : Mineral/material of size smaller than 5mm

High Temperature Thermal Analyzer(TG-DTA)

Research Area : Mineral characterisation



TG-DTA provides thermogravimetric analysis, differential thermal analysis and Differential thermogravimetric data simultaneously over change of temperature upto 1500°C in a given rate. It works with air environment only and provides the data in chart recorder. It is useful in thermal characterisation of minerals, oxy-hydroxide minerals specially clay minerals, limestone, dolomites,

Equipment Information

Model & Make : STA-409, Netzsch make

Year of Installation : 1983

Applications :

Resolution & Range : Temperature upto 1600°C

Sample : Powder sample of -200 mesh (smaller than 75 micron) size

Blaine Number Measurement Apparatus (Electronic Air Permeability Tester)

Research Area : Fine Particles



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

Applications :

Resolution & Range :

Sample : Powder

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 2020 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: 2020 TN Allround-Line Table Top Machine,
Make : M/s. Zwick Roell Pte Ltd, German

Year of Installation : 2014

Applications :

Resolution & Range :

Sample : Rock : $2.5 \times 2.5 \times 2.5 \text{ cm}^3$, Pellets : 10 – 15 mm Dia.

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 CO₂ is generated in the gas generation furnace for reduction of the samples and proper ratio of CO₂ and N₂ maintained. N₂ 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

Applications :

Resolution & Range :

Sample : Iron ore, Iron ore Sinter and Iron ore indurate pellets

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

Applications :

Resolution & Range :

Feed Capacity : 0.6-2.2 tons/hr

Operating G force : 30-90 g

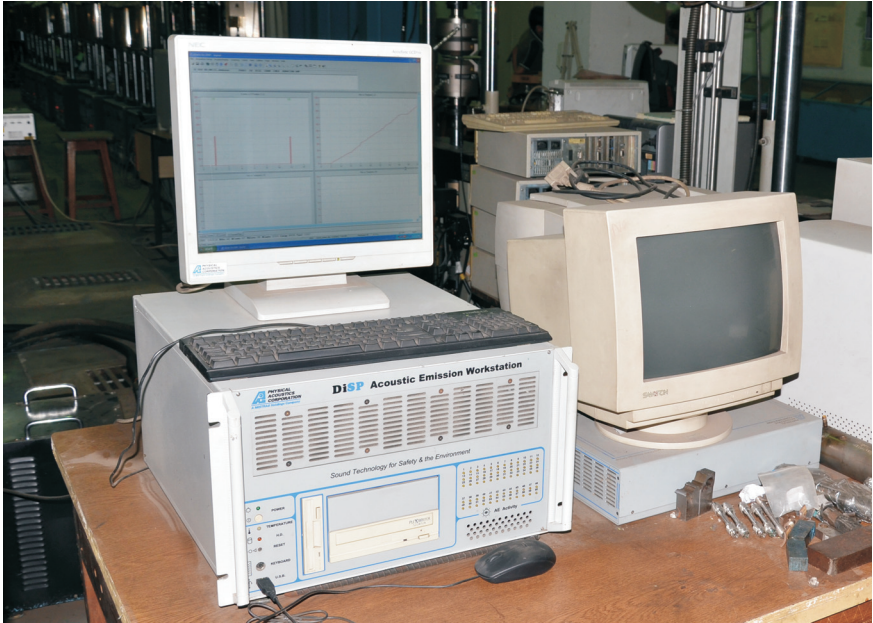
Sample :



Materials Evaluation and Characterization

Acoustic Emission Test System

Research Area : Non-destructive Evaluation



Acoustic emission (AE) is a transient elastic wave generated due to rapid release of energy from a localized source within a material due to defect formation or growth. AE testing is a very important non-destructive test (NDT) technique which facilitates the assessment of structural integrity by detecting the presence of active (dynamic) flaws such as cracks whose growth may ultimately cause failure of the component. Sources of AE in a material include local dynamic movements, such as the initiation and propagation of cracks, active corrosion, twinning, slip or plastic deformation, sudden reorientation of grain boundaries, martensite phase transformations etc.. Of these, the AE signal intensity due to crack dynamics is generally higher than that of other sources and therefore is more likely to be detected.

Equipment Information

Model & Make : 32-channel DISP Acoustic emission Test system,
Physical Acoustic Corporation, USA

Year of Installation : 2005

Applications : Condition monitoring of in-service components/pressure
containment vessels/structures

Resolution & Range : 32- channels of AE, 150KHz Sensors, AEWin Disp32

Sample :

Atomic Force Microscope

Research Area : Materials Characterization



Scanning Probe Microscope at NML was installed in the year 2004. It works at ambient conditions, is mounted on a vibration free table and has vibration proof chamber to reduce noise. The tip vibrations are monitored by a laser diode based detection system.

There are seven different modes of operations for capturing images of the surfaces of solid samples by Scanning Probe Microscope (SPM). Atomic Force Microscope (AFM), Deflection Force Microscope (DFM), Magnetic Force Microscope (MFM), Visco-Elasticity Atomic Force Microscope (VE-AFM), Visco-Elasticity - Dynamic Force Microscope (VE-DFM), Scanning Tunneling Microscope (STM) and Electro Chemical- Scanning Tunneling Microscope (EC-STM) are these modes which require appropriate selection of probes for capturing vary high resolution images. Two scanners are available : 20 and 100 μ m which scans down to atomic resolution.

Equipment Information

Model & Make : SII, Seiko Instruments Inc., Japan, SPA-400

Year of Installation : 2004

Applications : To characterize Metallic, Ceramic and Biological samples

Resolution & Range : The X-Y resolution is 1 $\text{\AA}$ and Z-resolution is 0.1 $\text{\AA}$.

Sample : Samples upto a maximum diameter of 35 mm and thickness 5 mm

Computer controlled Ultrasonic C Scan System

Research Area : Non-destructive Evaluation



Ultrasonic c-scan system is used to identify the cleanliness of materials in terms of inclusions, defects etc through 2D and 3D images. This system is used to scan a material in a noncontact way by immersing it in a tank filled with water. Frequency range of the system is up to 20MHz. 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.

Equipment Information

Model & Make : Physical Acoustics

Year of Installation : 2007

Applications :

Resolution & Range : 25 m spatial resolution

Sample : Solid sample with Two Flat parallel faces of any shape

Creep Testing Facilities (206 test points)

Research Area : Mechanical Behaviour of Materials



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.

Creep Testing Facilities (206 test points)

Equipment Information

Model & Make :

Year of Installation :

Applications :

Resolution & Range :

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 (8mm thick including curvature)

Creep-Fatigue Test Machine

Research Area : Mechanical Behaviour of Materials



NML has 3 numbers of dedicated electro-mechanical screw driven system (3.2T 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

Equipment Information

Model & Make : Instron 8861

Year of Installation : 2011

Applications : Creep-Fatigue Interaction

Resolution & Range : 32kN

Sample : Round cylindrical specimen

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 set-ups for carrying measurement 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 controlled atmosphere (Argon, He, N₂).

Equipment Information

Model & Make : Perkin Elmer: Model-PYRIS Diamond DSC

Year of Installation : 2008

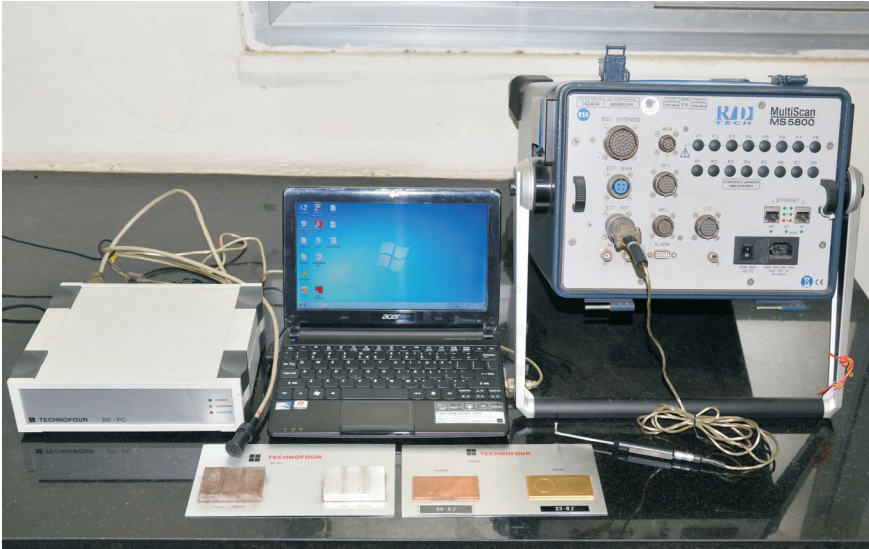
Applications : Measurement of Phase transition, activation energy, Kinetics of phase transformation.

Resolution & Range :

Sample : Metallic Strips: Thickness Few microns to 1mm, width 2 mm, length 2 mm, few milligrams. Powders of few milligrams.

Dual Frequency Multi-channel Eddy Current System

Research Area : Non-destructive Evaluation



Eddy current testing is a noncontact method used to inspect non ferromagnetic tubing. MS5800 system offers

- 4 simultaneous frequencies per input. This feature allows inspection speeds up to 2 m/s with 4 frequencies on absolute and differential channels, without signal distortion.
- Electronic probe balancing. No separate external reference probe is required for absolute channel operation.
- 4 ECT inputs and up to 64 multiplexed channels. The MultiScan™ MS 5800E can support a large number of ECT channels to perform array probe inspections. Compared to single-channel inspection, the array probe technology allows faster and easier surface coverage.

Equipment Information

Model & Make : MS5800, RD Tech. Olympus

Year of Installation : 2006

Applications : This technique is suitable for detecting and sizing metal discontinuities such as corrosion, erosion, wear, pitting, baffle cuts, wall loss, and cracks in nonferrous materials.

Resolution & Range :

Sample : Tube Inspection

Electron Probe Micro Analyser (EPMA)

Research Area : Microstructural Characterization



Electron Probe Micro Analyser (EPMA) is a high resolution elemental analysis instrument combined with wavelength dispersive X-ray spectrometers (WDS) and energy dispersive (EDS) analyser. It can analyse elements both qualitatively and quantitatively. Depending on requirement W and LaB₆ 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 micron (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-slugs, weld overlay, cladding, etc.

Resolution & Range :

Operating Voltage : up to 30kV

Probe Current Range : 10^{-12} to 10^{-5} A

Image Resolution : SEI- 6nm (W); 5nm (LaB₆) at W.D.11mm, 30kV

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 - ~ 1000ppm

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.

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 chemical composition of compounds on the surface of a sample. It utilizes X-Rays (XPS), Ultraviolet light (UPS), or Auger electron (AES) to knock off photoelectrons from atoms of the sample. The energy content of these ejected electrons are then analyzed by a spectrometer to identify atomic percent of elements present in the surface (1 – 10 nm usually) of the sample, chemical state of the constituent elements and valance 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 option for the in-situ depth profile measurement. UPS can be used to characterize valence band of electronic materials at and below room temperature.

Equipment Information

Model & Make : M/s SPECS, Germany

Year of Installation : 2009

Applications :

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 7mm and thickness 5-10mm. Material should not have volatile substances

Field Emission Scanning Electron Microscope with EDS and EBSD (FEG-SEM with EDS & EBSD)

Research Area : Microstructural Characterization



FEI Nova NanoSEM 430, an ultra-high resolution field-emission SEM which is specifically configured to get the most information out of the largest selection of samples, down to the nanometer level. The Nova NanoSEM 430 has the capabilities of very low kV characterization as well as its analytical capabilities. Ultra-high resolution results can be obtained on a variety of challenging materials such as metals, magnetic materials, nano materials. Available nanoanalysis capabilities such as EDS and EBSD with Nova NanoSEM 430 will provide a powerful solution for the most demanding characterization needs at the nanoscale.

Equipment Information

Model & Make : FEI Nova nanoSEM-430

Year of Installation : 2010

Applications :

Resolution & Range : Resolution 1.0 nm at 15 kV Beam landing energy: 50 V - 30 kV high stability Schottky field emission gun ; Magnification : 800000x

Sample : Solid sample up to a maximum size of 25 mm x 25mm and thickness 5-20mm. Material should not have volatile substances.

High Power High Frequency Ultrasonic System

Research Area : Non-destructive Evaluation



It is a High power RF tone burst generator with output 5 kW up to 7 MHz

The system operates at Frequency Range of 40 kHz-20MHz. It can be used to Characterise 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 signal to excite PZT or magnetostrictive Sensors

Resolution & Range :

Sample : Flat samples of thickness >4mm

High Strain Rate Test Facility

Research Area : Mechanical Behaviour of Materials



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 : 250kN -20 m/s

Sample : Flat tensile, metallic cans, disc

Scanning Electron Microscope with Deformation Stage

Research Area : Microstructural Characterization



The Hitachi S-3400N SEM is a powerful user-friendly SEM with computerized automated functions. The excellent image quality convinces at high and low beam energies, and optimized detector technology provides maximum information from sample. This SEM is in operation at NML from December 2005. A BSE detector allows TV rate scanning and high resolution imaging. Hitachi's patented Quad variable gun bias and SE accelerator plate ensures high currents for low voltage applications. Variable chamber pressure allows charge-up free observation of any sample without special preparation techniques such as coating. In-situ microstructural changes in SE & BSE mode can be observed during tensile/deformation test with Gatan 2kN MTEST

Equipment Information

Model & Make : Hitachi S-3400N SEM

Year of Installation : 2005

Applications :

Resolution & Range : Resolution -3.0 nm at 30 kV Beam landing energy : 300 V - 30 kV, high W-filament electron gun gun ; Magnification : 300000x

Sample : Solid sample up to a maximum size of 25 mm x 25mm and thickness 5-20mm. Material should not have volatile substances.

Instrumented Charpy Machine

Research Area : Mechanical Behaviour of Materials



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_{ID} and the ductile to brittle transition temperature (DBTT) of metals and alloys. The system is equipped with a temperature bath in the range of $+150^{\circ}\text{C}$ 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 : 450J

Sample : Charpy V-notch

Laser Flash Thermal Diffusivity Instrument

Research Area : Materials Characterization



Laser Flash Thermal Diffusivity Instrument : Thermal diffusivity of solid materials is measured by exposing the front surface of the specimen to a high intense short duration radiant energy (laser pulse). Specimen absorbs the incident energy of the pulse which results in a temperature rise on the rear surface of the specimen. This temperature rise is recorded to obtain a thermogram and the time required to reach the maximum temperature rise of the sample is measured to determine thermal diffusivity of the material. Measurement follows ASTM E-1461 procedure. This instrument can also be used to determine specific heat and thermal conductivity by comparative measurements on a standard sample and specimen simultaneously. Measurements can be done in air, vacuum or inert atmosphere.

Equipment Information

Model & Make : FL-5000, Anter corporation, USA,

Year of Installation : 2004

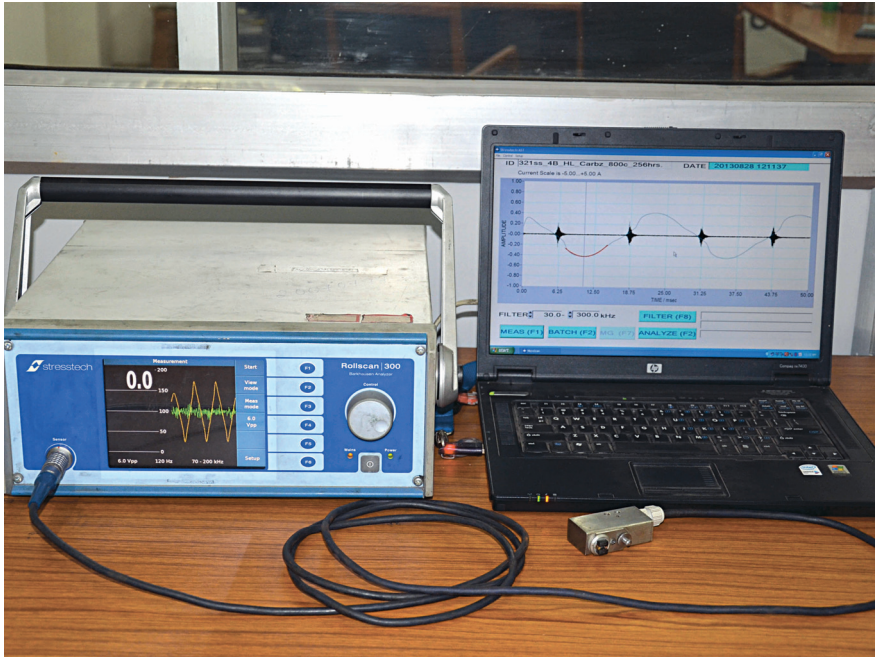
Applications : Determination of thermal properties of solid materials from room temperature to 1400°C

Resolution & Range :

Sample : Disc samples of 12.7 mm diameter with both surfaces optically flat. Thickness of the sample needs to be optimized depending on the thermal conductivity of the sample.

Magnetic Barkhausen Emission Analyzer

Research Area : Non-destructive Evaluation



Magnetic Barkhausen Emission Analyzer : The Magnetic Barkhausen emission (MBE) is measured by the the instrument Rollscan 300 which is a digital Barkhausen noise analyzer. This instrument can be used for measurement of 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 : Model: Rollscan - 300, America, Strentech

Year of Installation : 2007

Applications : Magnetic Barkhausen signal in ferritic steel, Iron, Cobalt and nickel.

Resolution & Range :

Sample : Plates, Pipes, Tubes, Cylinders. The contact area required for the probes is 10mm x 10mm.

Miniature Specimen Test System

Research Area : Mechanical Behaviour of Materials



Miniature Specimen Test System is the dynamic testing machine exclusively to study 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 100Hz that 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 really a small volume of material. The system is ideal for industries that cannot spare large volume of material that are typically required in destructive experiments and for those research organizations who are desirous to know the behaviour of materials across the length scale.

Equipment Information

Model & Make : Electropulse 3000, Instron UK

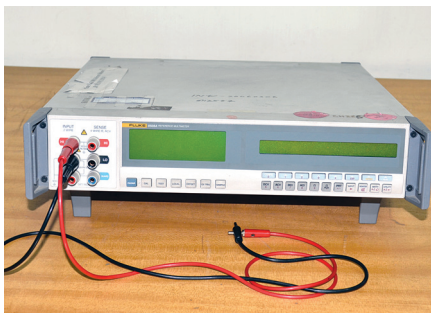
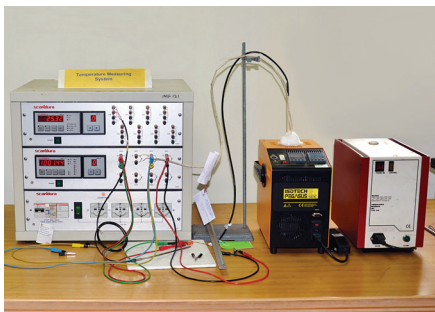
Year of Installation : 2010

Applications : tensile, high and low cycle fatigue, fracture toughness (KIC, JIC) and fatigue crack growth rate (FCGR)

Resolution & Range : Dynamic Capacity: 3kN; Static Capacity: 2.1kN; (load cells with 1000N, 500N are also available); Freq: 0.1Hz to 300Hz

Sample : Flat /round specimens of 0.1 to 6mm thickness/3–6mm grip diameter, TPB: 5mm x 5mm x 25mm, Disc/CT: 12.5mm width x variable thickness

Temperature-Pressure Calibration Equipments



Background : NML-NPL Centre for Calibration - An ISO 9001-2008 Certified Laboratory is first of its kind set up in December 3, 1999 by two national laboratories, National Metallurgical Laboratory (NML), Jamshedpur and National Physical Laboratory (NPL), New Delhi. The centre has primarily been established to cater to the need for in-house calibration. However, it also provides calibration services to the industry and other laboratories. To cater standard needs of the industrial institutions, the laboratory maintains high accuracy standards/calibrators in the field of thermal, electrical and mass metrology. The Centre located at NML Jamshedpur strives for Better Value for Money to its customers.

Equipment Information

Model & Make :

Year of Installation :

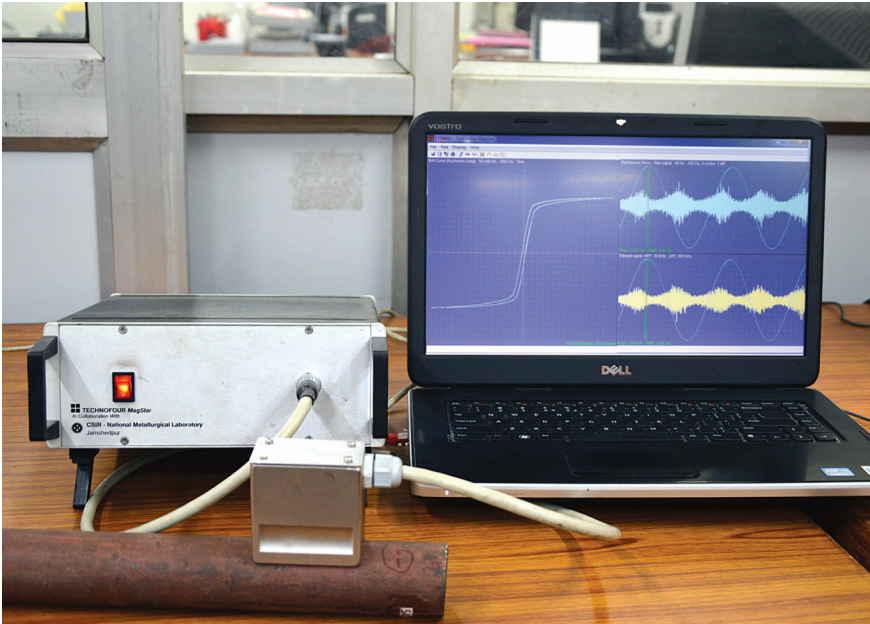
Applications :

Resolution & Range :

Sample :

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 frequency range of 50 mHz to 200Hz for magnetising the test object as well as receiving MBE and MHL signals of from the test object

Resolution & Range :

Sample : Plates : length 100mm (min), width 10 mm (min), thickness 2mm to 10mm, Pipes : length 100mm diameter 50 - 100mm, Rolls

Precision Impedance Analyser

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: $\pm 0.08\%$. Excellent High Q/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 μ A 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 and 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, Q-factor, Dissipation Factor, Permeability etc. of electric/ferro-electric materials

Resolution & Range :

Sample : flat samples of square or round shaped with conducting coating on both the surfaces. Preferable with leads.

Servo-electric dynamic test machines

Research Area : Mechanical Behaviour of Materials



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 (upto 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 : 100kN

Sample : Round/Flat (tensile, LCF); CT/TPB(FCGR, Fracture)

Servo-hydraulic mechanical testing systems

Research Area : Mechanical Behaviour of Materials



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 50T 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.

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

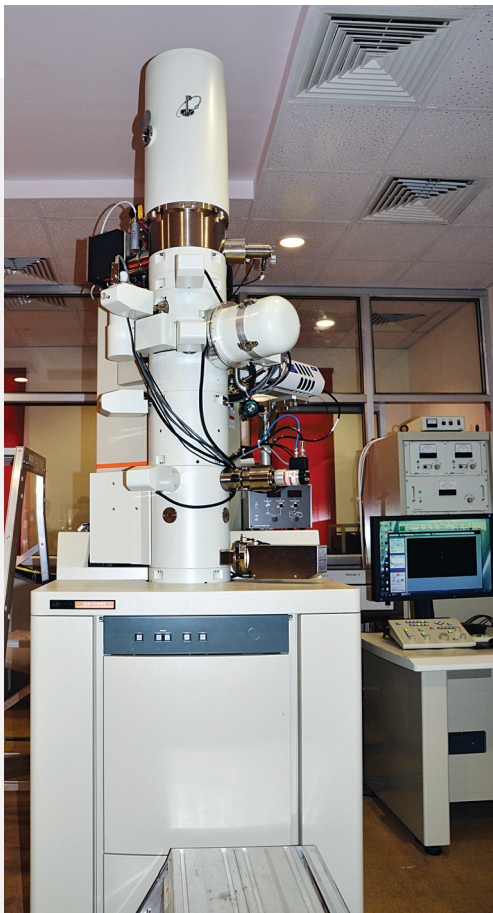
Resolution & Range : 50kN and 100kN

Sample : Flat, round (tensile, fatigue), CT/TPB (fracture, FCGR)

Transmission Electron Microscope

The JEOL JEM 2200FS is an advanced and unique transmission electron microscope (TEM) that covers a range of imaging mode and spectroscopic applications. The state of the art analytical equipment, equipped with 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 becomes fully operational from early of 2014. It is one of a new generation TEM 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 easy to compare TEM images and diffraction patterns. The instrument has in-column Ω -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, DF detectors. The STEM- EDS acquisition mode adds great advantages for point and elemental mapping for compositional analysis of different phases. The EDS equipped with SDD detector having 80mm² aperture where small amount 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).



JEOL JEM 2200FS TEM

Equipment Information

Model & Make :

Year of Installation :

Applications :

For structural characterization and crystallographic study of metals, ceramic, alloys, amorphous materials, non-magnetic powder sample, thin film etc. (no polymer sample/ carbonaceous organic material will not be entertained). Available modes are TEM BF, SADP, DF, EDS, EELS, STEM, NBD & CBED

Range and resolution

Point-image Resolution	0.23nm at 200kV
Lattice resolution	0.1 nm at 200kV
Accelerating Voltage	80 to 200kV in steps
Magnification	X (100-1,500,000)
Specimen tilt	$\alpha = \pm 30^\circ$

Sample :

- I. Electron transparent samples prepared by twin jet electro-polished for metallic/alloy samples.
- II. Perforated electron transparent ceramic samples.
- III. Non-magnetic powder samples.

It is always preferable; specimens should free from hydrocarbon contamination or sought after plasma cleaning of the specimen.

TEM Sample preparation facilities



Slow Speed Diamond Saw	Bhueler- for thin slice cutting
Twin Jet Electro Polisher	Struers Tenupol 5- for electropolishing
Ultrasonic Disc Cutter	South Bay Technology, Model SoniCut 380 - for 3mm disc cutting of brittle samples
Dimple Grinder	South Bay Technology, Model 500i - for mechanical thing 3mm disc of brittle samples prior to ion-milling
Ion Milling Unit	Technoorg Linda Ltd. Co., LINDA, Model Pro IVA, - for thing of brittle samples. Gun energy from 10 KV to 100 ev with focused gun
Plasma Cleaner	Fillunger, EM-PC-100- for removing hydrocarbon contamination and hence improves image quality
Evaporation Unit	Quorum Technologies, Model Q150T- for coating and used for producing replica of TEM samples along with thickness measurement facility

Transmission Electron Microscope

Research Area : Materials Characterization

Analytical Transmission Electron Microscope is a powerful instrument in the field of materials characterisations in nanometer and sub-nanometer level. Maximum operating voltage is ~ 200 kV in steps of 80, 120 and 160 kV. Magnification range is 3.5 to 600 Kx in SA mode with a resolution of ~ 2.84 Å using twin lenses. Images may be captured digitally through bottom mounted CCD camera. As an analytical facility ultra thin window Energy Dispersive Spectroscopy (EDS, EDAX Genesis) is attached with TEM. EDS has an ability of qualitative and quantitative analysis of elements starting from boron to uranium. Different sample holders like single tilt, double tilt and low back ground double tilt are available to cater different needs. Imaging options are Bright field (BF), Dark field (DF), Selected area diffraction pattern (SADP), convergent beam electron diffraction (CBED) and nano beam.

Sample preparation units such as slow speed diamond saw (Bhueler), twin jet electro polisher (Struers Tenupol 52 Fishi one), ultrasonic disc cutter, dimple grinder, ion miller and plasma cleaner are available.



Equipment Information

Model & Make : Philips CM 200 D825 & EDAX GENESIS 2000

Year of Installation : 1997 & 2008

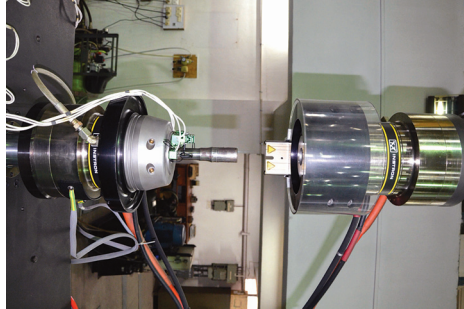
Applications : For structural characterization and crystallographic study of metals, materials, alloys, glassy substances, amorphous materials, non-magnetic powder sample, thin film etc (no polymer sample / carbonaceous organic material)

Resolution & Range : Magnification up to 600KX with alpha tilt $\pm 55^\circ$ and beta tilt $\pm 10^\circ$. Resolution ~ 2.84 Å; EDS resolution is 240eV

Sample : twin jet polished thin metallic / alloy samples, powder sample, thin film, perforated electron transparent ceramic material

Tension-Torsion Test System

Research Area : Mechanical Behaviour of Materials



This unique facility is 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 analogues to those of actual components. The system has an axial capacity of $\pm 100\text{kN}$ and torsional capacity of 1000Nm . The maximum internal pressure that can be applied using a special unit is 600 bar . The system also has 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 : 100kN axial; 1000Nm torque

Sample : Tubular specimens of 25mm outer diameter in gauge section and 32mm diameter in end section

Thermal Electrical Resistivity (TER) System

Research Area : Materials Characterization



Thermal Electrical Resistivity (TER) System:—The Thermal electrical resistivity instrument performs to measure temperature vs. electric resistivity change of the materials by four probe method using a programmable infra red gold image furnace. Measurement can be carried out in vacuum/inert atmosphere. Electrical resistivity variation can be measured at temperature Ranges : (I) High temperature : Room temperature to 1000°C (ii) Low temperature: 80K to 400 K.

Equipment Information

Model & Make : Model: TER-2000RH/L, Make: Ulvac Inc, Japan

Year of Installation : 2009

Applications : For the measurement of resistivity variations during phase transformations and recrystallization.

Resolution & Range :

Sample : Metals and alloys. Samples in the form of rods and wires of diameter 200 μm to 5mm and length 40- 80mm. Strips with thickness 200 μm to 5mm wires and width 5-10 mm, length 40- 80mm.

Transport Property and Magnetic Measurement System

Research Area : Materials Characterization



The Transport property measurement system can be used to measure the change in resistivity with magnetizing field and temperature. The system has an attachment for measuring magnetization with applied magnetic field. Measurement can be carried out in the temperature ranges : 50K to 400 K. Measurements can be carried out in vacuum/ inert atmosphere. Maximum magnetizing field is 30 kilogauss (3.0 Tesla).

Equipment Information

Model & Make : Quantum Design, Versalab, USA

Year of Installation : 2006

Applications : Measurement of saturation magnetization, Initial magnetization (Variation of resistivity with magnetizing field in temperature range 50K to 400K).

Resolution & Range :

Sample : Strips: Thickness 20 μm to 2mm, width 2 mm and length 2 mm. Powders: Few milligrams.

Ultrasonic Cavitation Erosion Testing Machine

Research Area : Materials Evaluation



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.

Equipment Information

Model & Make : UPS: 2000 & M/s Roop Telsonic Ultrasonix Ltd. Mumbai

Year of Installation : 2009

Applications :

Resolution & Range :

Output Frequency : 20KHZ; Output Power : 1.0KW;

Mode of operation : (a) Constant Amplitude mode (50 μ m) (b) Constant Power mode;

Ultrasonic Out : Continuous Mode/Pulsed Mode;

Sample : Any material which can be made to the standard samples.

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

Resolution & Range :

Sample : Flat welded samples, Pressure vessels

Vacuum/Inert melt spinning unit

Research Area : Advanced Materials Processing



The Melt spinning unit involves rapid solidification processing route through 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 in inert atmosphere. The instrument has the capability of melting 1kg 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.

Resolution & Range :

Sample : Input material: Alloy ingots typically for ferrous alloys with diameter = 20 to 25 mm, height ~ 100mm, weight ~ up to 1kg of Fe-based alloy. Output material: Ribbons of up to 25mm width and 30-50 microns thickness.

Vibrating Sample Magnetometer

Research Area : Advanced Materials Processing



The Vibrating sample magnetometer (VSM) can be used to measure the change of magnetization with applied field and temperature. Measurement can be carried out at low and high temperature ranges : (i) High temperature : Room temperature to 1000°C and (ii) Low temperature : 80K to 400 K. Thermal measurements can be carried out in vacuum /inert atmosphere. Maximum magnetizing field is 12kilogauss (1.2Tesla)

Equipment Information

Model & Make : Lakeshore Model: 7404, USA

Year of Installation : 2006

Applications : Measurement of saturation magnetization, initial magnetization and Curie temperature.

Resolution & Range :

Sample : Strips: Thickness 20 μm to 2mm, width 2 mm and length 2 mm. Powders : Few milligrams.

High resolution and high temperature 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 characterisation of thin films. The high temperature camera (upto 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 diffratometer 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 0.0001deg. Output - Plot

Sample : Solid or powder samples

Madras Centre



Laser Particle Size Analyzer



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 the particles are of spherical in nature. The analysis involves both dry and wet mode of operation depending upon the nature and size of the particles. This instrument measures particle size ranging from $0.04\mu\text{m}$ to $2500\mu\text{m}$.

Equipment Information

Model & Make : M/s CILAS 1180, France

Year of Installation : 2002

Applications :

Resolution & Range :

Sample : Powder & slurry

Surface Area Analyzer



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 surface of the sample. The amount of gas adsorbed at a given pressure allows determining the surface area. Pore volume and pore area distributions in the mesopore and macropore ranges 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

Applications :

Resolution & Range :

Sample : Powder & solids

ZETA SIZER



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

Applications :

Resolution & Range :

Sample : Powder & slurry

Tensiometer



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. Surface tension of liquids, interfacial tension between two liquids can be measured. The measurement method involves both ring and plate (with highly accurate contours) mode of operation. The measurements can be made between temperatures varying from RT to 130°C.

Equipment Information

Model & Make : M/s Kruss K100, Germany

Year of Installation : 2004

Applications :

Resolution & Range :

Sample : Powders, solids & liquids

Rheometer



Rheological tests both in rational and oscillatory mode can be determined using rheometer. It measures viscosity, flow curves, yield point, 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 oscillatory test method. The measurement method involves both cone and plate type of operation depending upon the viscous nature of the sample.

Equipment Information

Model & Make : M/s Anton Paar Physica MCR 101, Germany

Year of Installation : 2005

Applications :

Resolution & Range :

Sample : Powders, solids & slurry

Gas Pycnometer



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 AccuPyc II 1340, USA.

Year of Installation : 2007

Applications :

Resolution & Range :

Sample : Powders & solids

Micro Indentation Hardness Tester

Research Area : Microstructural Characterization



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.

Equipment Information

Model & Make : M/s Leica VMHT Microindentation Hardness tester, Germany

Year of Installation : 2000

Applications :

Resolution & Range :

Sample : Metallographically polished (mirror finish) samples up to a maximum size of 20 mm x 20 mm and thickness 1-10mm.

Metallurgical Microscope with Image Analyzer

Research Area : Microstructural Characterization



Metallurgical microscope is used to study the structure of metallographically prepared metal /alloy samples at magnifications $>50\times$. 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 also can be determined. Using the dedicated digital camera attached with the microscope, the live images are captured and saved onto digital media for easy use and data storage.

The Leica QWin Image Analyser can be employed for quantitative metallography studies and to obtain reliable, quick and reproducible results.

Equipment Information

Model & Make : M/s Leica DMLM metallurgical microscope, Germany

Year of Installation : 2000

Applications :

Resolution & Range :

Sample : Metallographically polished (mirror finish) samples up to a maximum size of 20 mm x 20 mm and thickness 1-10mm.



CSIR-National Metallurgical Laboratory

Jamshedpur - 831007, India

Phone : 91-657-2345028 /2345000-001, Fax : 91-657-2345213

e-mail : director@nmlindia.org, Website : www.nmlindia.org