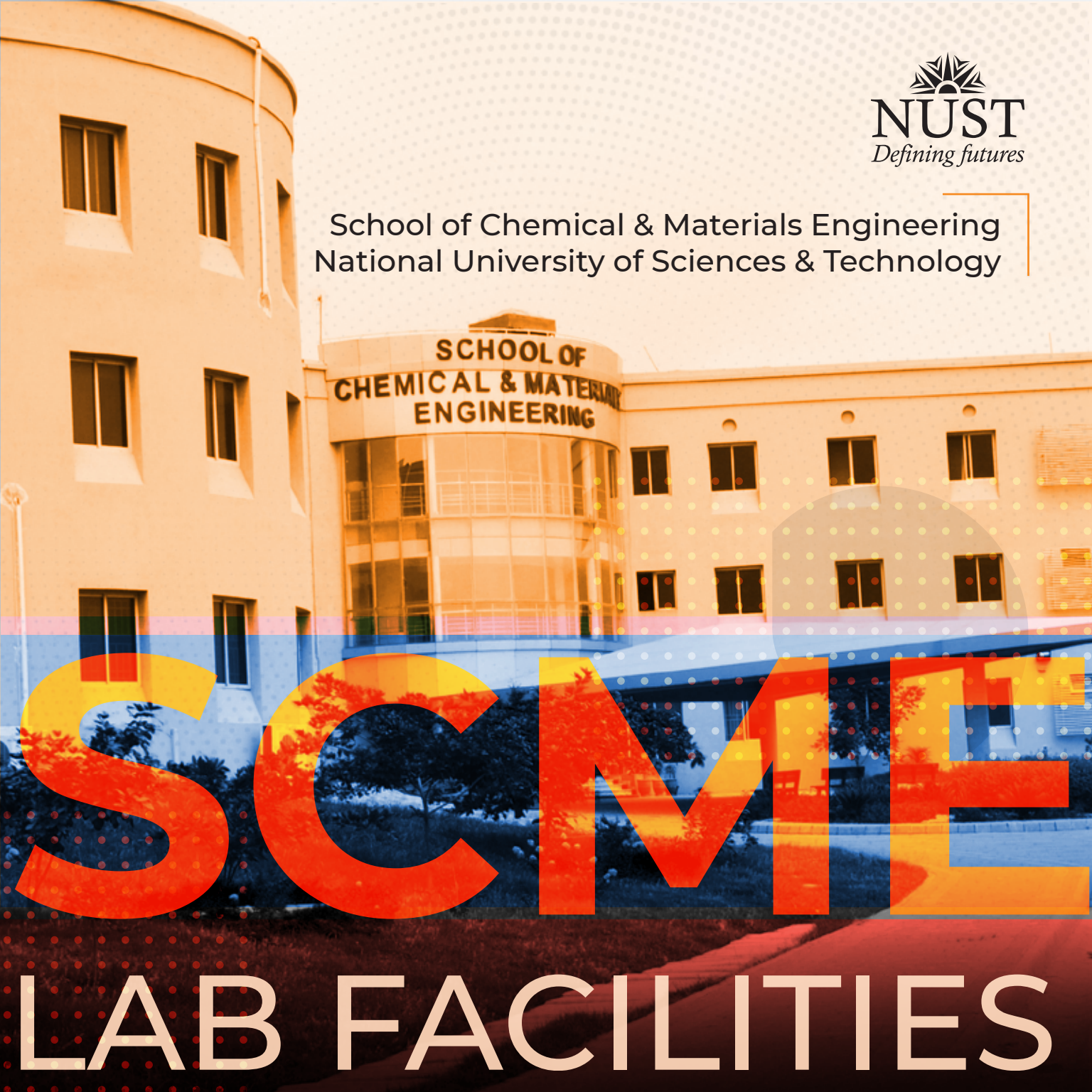
NUST
Defining futures

School of Chemical & Materials Engineering
National University of Sciences & Technology



SCME

LAB FACILITIES

SCME Profile

School of Chemical and Materials Engineering (SCME) commenced its programs in 2006 and is currently offering undergraduate and postgraduate degree programs in the twin disciplines of Chemical Engineering and Materials Engineering. Internationally recognized faculty, coupled with well-equipped state-of-the-art labs and learning resources, provide an ideal platform for the professional growth of all stakeholders.

Lab Facilities Portfolio

SCME is equipped with state-of-the art equipment to cater for the characterisation and analysis of materials viz. X-Rays Diffraction (XRD), Scanning Electron Microscopy (SEM), Fourier Transform Infrared Spectroscopy (FT-IR), High Performance Liquid Chromatography (HPLC), Gas Chromatograph Mass spectrometer (GC-MS), Ultraviolet-Visible Spectroscopy (UV-Vis) and Elemental Analyzer (EA) to name a few. SCME also has a strong tradition of holding workshops and seminars on contemporary topics of interest in the area of characterisation and analytical techniques for academia and industry professionals. The details about lab testing facilities available at SCME can be found in the brochure. This lab brochure is an effort to outreach the relevant industry and defense/ strategic organisations, so that strong linkages between industry and academia can be established.

It is my privilege to lead and share the R&D facilities available at SCME.

Prof Ir Dr Amir Azam Khan
Principal SCME, NUST
Email: principal@scme.nust.edu.pk
Contact number: 051-90855001

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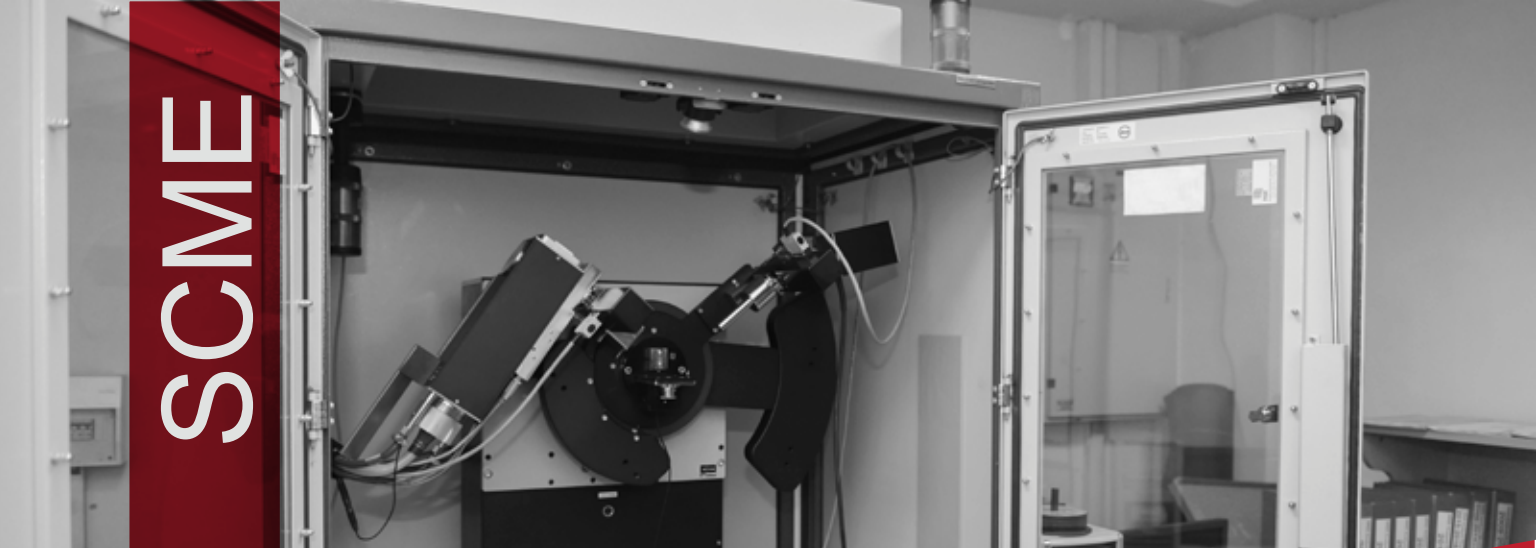

X-Ray Powder Diffractometer (XRD)

INTRODUCTION

X-ray Diffraction is a characterisation technique based on constructive interference of monochromatic X-rays and a crystalline sample. Constructive interference when conditions satisfy Bragg's Law ($n\lambda = 2d \sin \theta$). This relates the wavelength of electromagnetic radiation to the diffraction angle and the lattice spacing in a crystalline sample.

Working Principle

X-ray diffractometers consist of three basic elements: An X-ray tube, a sample holder, and an X-ray detector. X-rays are generated in a cathode ray tube by heating a filament to produce electrons, accelerating the electrons toward a target by applying a voltage, and bombarding the target material with electrons. When electrons have sufficient energy to dislodge inner shell electrons of the target material, characteristic X-ray spectra are produced. Copper is the most common target material for single-crystal diffraction. These X-rays are collimated and directed onto the sample. As the sample and detector are rotated, the intensity of the reflected X-rays is recorded. When the geometry of the incident X-rays impinging the sample satisfies the Bragg Equation, constructive interference occurs and a peak in intensity occurs. A detector records and processes this X-ray signal as output. For typical powder patterns, data is collected at 2θ from ~5° to 70°, angles.

Application

X-ray powder diffraction is most widely used for the identification of unknown crystalline materials (e.g. minerals, inorganic compounds). Determination of unknown solids is critical to studies in Geology, Environmental Science, Material Science, Engineering and Biology.

Other applications include:

- Characterisation of crystalline materials
- Identification of fine-grained minerals such as clays and mixed layer clays that are difficult to determine optically
- Determination of unit cell dimensions
- Measurement of sample purity
- Determination of crystal structures using Rietveld refinement
- Determination of modal amounts of minerals (quantitative analysis)
- Characterisation of thin films samples

Specifications

Make	STOE Germany
Model	Theta-Theta S/N 65022
Angle	5°-160°
Angle geometry	θ - θ
Step size (min)	0.004 degrees
Radiation	Cu K alpha

Indicative price per sample

PKR 5,000/-

(Actual testing rates vary according to the type of sample and customer requirements)

For further queries or reservation of equipment for sample testing, please contact

Head of Materials Engineering Department
hodme@scme.nust.edu.pk
051-90855200/201

Dr Iftikhar Hussain Gul
Professor, Department of Materials Engineering
Email: iftikhar.gul@scme.nust.edu.pk
Landline: 051-90855206

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Scanning Electron Microscope (SEM)

INTRODUCTION

Scanning Electron Microscope (SEM) is used to study morphology of a material based on interaction of electron beam with atoms at various depths within sample. It produces images by scanning the surface with a beam of electrons. The mode of detection is secondary electrons emitted by atoms excited by the electron beam.

Working Principle

A Scanning Electron Microscope (SEM) scans a focused electron beam over a surface to create an image. The electrons in the beam interact with the sample, producing various signals that can be used to obtain information about the surface topography and composition of the sample. The electron beam is scanned in a raster scan pattern, and the position of the beam is combined with the intensity of the detected signal to produce an image. In the most common SEM mode, secondary electrons emitted by atoms excited by the electron beam are detected using a secondary electron detector. The number of secondary electrons that can be detected, and thus the signal intensity, depends, among other things, on specimen topography.

Application

Scanning electron microscopy can be used in a variety of industrial, commercial, and research applications. This characterisation technique widely is used in research, quality control and failure analysis in material science industry. Some applications are:

- 3D images of Topography, Morphology and Composition
- Failure analysis (metallurgy)
- Microchip assembly
- Forensic investigations
- Medical science
- Soil and rock sampling
- Biological science
- Electronics
- Aerospace

Specifications

Make	JEOL Japan
Model	JSM-6490A
Resolution	3nm
Magnification	5x to 300000x
Secondary Electron Detector	E.T detector
Filament	Tungsten

Indicative price per sample

PKR 5,500/-

(Actual testing rates vary according to the type of sample and customer requirements)

For further queries or reservation of equipment for sample testing, please contact

Head of Materials Engineering Department
hodme@scme.nust.edu.pk
051-90855200/201

Dr Khurram Yaqoob
Associate Professor, Department of Materials Engineering
khurram.yaqoob@scme.nust.edu.pk
051-90855211

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Brinell Hardness Tester

INTRODUCTION

Brinell Hardness Tester has a steel ball indenter. Upon applying force, it produces an indent of some specific diameter. Measurement of the diameter of the indenter is indirectly the measurement of hardness. Here the area of the indentation gives the hardness value i.e. the greater is the diameter, the smaller is the hardness and vice versa.

Working Principle

In the Brinell Hardness test, an optical method, the size of indentation left by the indenter is measured. In order to determine the Brinell Hardness, the spherical hard metal (tungsten carbide) indenter is pressed into a specimen with a defined test load (between 1 kgf and 3000 kgf). The Brinell Hardness results from the quotient of the applied test force and the surface area of the residual indent on the specimen (the projection of the indent) after withdrawing the test force. This test averages the hardness over a wider amount of material, which more accurately account for multiple grain structures and any irregularities in the uniformity of the material. This method is the best for achieving the bulk or macro-hardness of a material, particularly those materials with heterogeneous structures.

Application

Brinell hardness testing is typically used in testing aluminum and copper alloys (at lower forces) and steels and cast irons at the higher force ranges. Brinell Hardness test is used to find the hardness of

- Unquenched steels
- Bulk metals
- Ductile metals

Note: Hardness of ceramics of brittle materials cannot be found using Brinell Hardness Test.

Specifications

Make	Times group Inc China
Model	TH-600
Max load	3000 kgf
Testing load	187, 250, 750, 100, 3000 kgf
Indenter	Steel ball of diameter 10 mm

Indicative price per sample

PKR 600/-

(Actual testing rates vary according to the type of sample and customer requirements)

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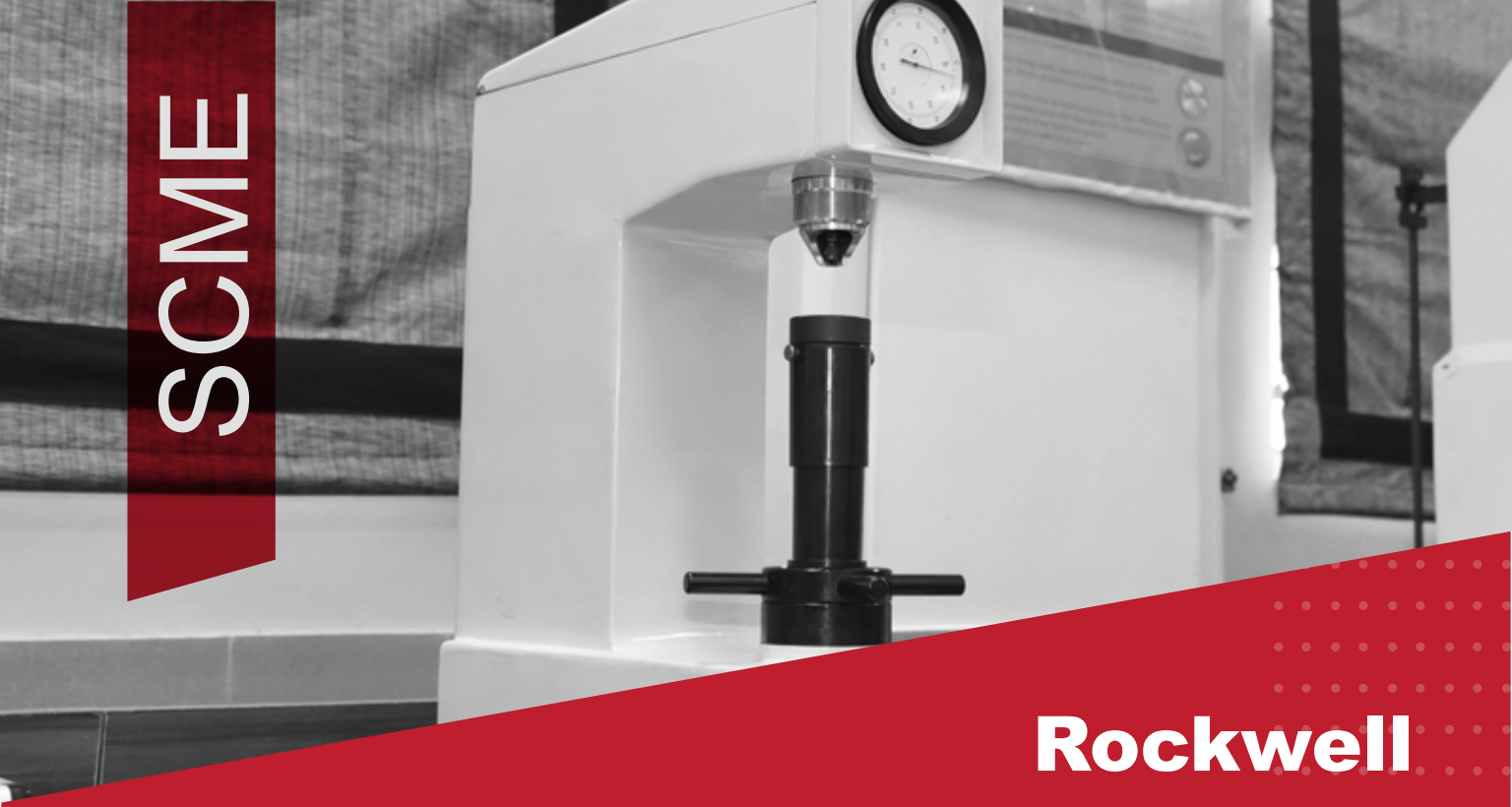
Head of Materials Engineering Department
hodme@scme.nust.edu.pk
051-90855200/201

Dr Adeel Umer
Assistant Professor, Department of Materials Engineering
umer.adeel@scme.nust.edu.pk
051-90855203

SCME



Rockwell Hardness Tester

INTRODUCTION

Hardness is a characteristic of a material, not a fundamental physical property. It is defined as the resistance to indentation, and it is determined by measuring the permanent depth of the indentation. More simply put, when using a fixed force (load) and a given indenter, the smaller the indentation, the harder the material.

Working Principle

The Rockwell Hardness Test is one of several common indentation hardness tests used today. Most indentation hardness tests are a measure of the deformation that occurs when the material under test is penetrated with a specific type of indenter. In the case of the Rockwell Hardness Test, two levels of force are applied to the indenter at specified rates and with specific dwell times. Unlike the Brinell and Vickers Tests, where the size of the indentation is measured following the indentation process, the Rockwell Hardness of the material is based on the difference in the depth of the indenter at two specific times during the testing cycle. The value of hardness is calculated using a formula that was derived to yield a number falling within an arbitrarily defined range of numbers known as a Rockwell Hardness Scale.

Application

Rockwell testing is the most frequently used method as a "quick test" in production or in the laboratory and is usually used on alloys and metals. It is used to find the hardness of following materials

- Mild Steel (on B scale)
- Aluminum Alloy (on B scale)
- Copper Alloy (on B scale)
- Malleable Cast Iron (on B scale)
- Quenched Steel (on C scale)
- Tempered Steel (on C scale)
- Hard Cast Iron (on C scale)

Specifications

Make	Sinowon China	
Model	SHR-150E	
Parameters	Scale	Values
Ball indenter	B	1.6 mm
Minor load	B	10 kgf
Major load	B	90 kgf
Diamond Indenter Conical Angle	C	120°
Minor Load	10 kgf	140 kgf

Indicative price per sample

PKR 600/-

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Head of Materials Engineering Department
hodme@scme.nust.edu.pk
051-90855200/201

Dr Adeel Umer
Assistant Professor, Department of Materials Engineering
umer.adeel@scme.nust.edu.pk
051-90855203

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Impact Testing Machine

INTRODUCTION

Impact Testing Machines evaluate an object's capacity to withstand high-rate loading and it is commonly used to determine the service life of a part or material. Impact resistance can be among the most challenging qualities to measure. Impact tests are used in studying the toughness of material. A material's toughness is a factor of its ability to absorb energy during plastic deformation.

Working Principle

Notched-bar impact test of metals provides information on failure mode under high velocity loading conditions leading sudden fracture where a sharp stress raiser (notch) is present. The energy absorbed at fracture is generally related to the area under the stress-strain curve which is termed as toughness in some references. Brittle materials have a small area under the stress-strain curve (due to its limited toughness) and as a result, little energy is absorbed during impact failure. As plastic deformation capability of the materials (ductility) increases, the area under the curve also increases and absorbed energy and respectively toughness increase. Similar characteristics can be seen on the fracture surfaces of broken specimens.

Application

Impact test is used to predict behavior of a material under actual conditions. Many materials can fail suddenly under impact, at flaws, cracks, or notches. It is used to find the hardness of following materials

- Steels, nonferrous metals, IC wafer
- Thin plastic, metallic foils
- Plating, coating
- Surface layers, thin ceramic coatings, laminated metals
- Effect of heat treatment and depths of carburised layer and flame or induction hardened layer

Indicative price per sample

PKR 1,000/-

(Actual testing rates vary according to the type of sample and customer requirements)

Specifications

Make	Brooks England
Model	IT3u
Parameters	Values
Diamond indenter	Pyramid shape
Minimum load	10 g
Maximum load	100 g
Resolution	0.1 µm
Measuring range	200 µm
Hardness value	5-digit
SDiagonal length	4-digit (D1, D2)
Maximum specimen Height	85 mm (2.55”)
Operating temperature	Range: 10 to 38 °C (50 to 100 F)

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Head of Materials Engineering Department
hodme@scme.nust.edu.pk
051-90855200/201

Dr Adeel Umer
Assistant Professor, Department of Materials Engineering
umer.adeel@scme.nust.edu.pk
051-90855203

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Universal Testing Machine

INTRODUCTION

Mechanical testing includes tensile testing, bend testing, compression testing, peel testing and many more. The "universal" part of the name reflects that it can perform many standard tensile and compression tests on materials, components, and structures. Types of materials we can test on this machine include metals, polymers and membranes.

Working Principle

A Universal Testing Machine (UTM) is used to test the mechanical properties (tension, compression etc.) of a given test specimen by exerting tensile, compressive or transverse stresses. Different tests like peel test, flexural test, tension test, bend test, friction test, spring test etc. can be performed with the help of UTM. A universal testing machine consists of two main parts, loading unit and control unit.
The arrangement of the test specimen and the exertion of the load is held in the loading unit. The variations in the application of the load and the corresponding test result are obtained from the control unit.

Application

Universal Testing Machine can be used in various areas such as metal and steel industry, plastic industry, automotive industry, research, solar industry, medical technology, glass industry, aviation and aerospace industry. It is used to perform the following test:

- Tensile test
- Three-point bend test
- Four-point bend test
- Compression test
- Peel test

Specifications

Make	Shimadzu Japan
Model	AGX-Plus
Max force	50kN
Strain Rate	0.0001-1000 (mm/min)
Max thickness	7mm (flat sample)
Max width	24mm (flat sample)
Max diameter	4-9mm (round sample)

Indicative price per sample

PKR 600/-

(Actual testing rates vary according to the type of sample and customer requirements)

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Head of Materials Engineering Department
hodme@scme.nust.edu.pk
051-90855200/201

Dr Adeel Umer
Assistant Professor, Department of Materials Engineering
umer.adeel@scme.nust.edu.pk
051-90855203

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Particle Size Analyser

INTRODUCTION

Particle size analyser is a laboratory equipment which determines the size range, and/or the average, or mean size of the particles in a powder or liquid sample. The particle size measurement is determined by Particle Size Analysers (PSA) which are based on different technologies, such as high definition image processing, analysis of Brownian motion, gravitational settling of the particle and light scattering (Rayleigh and Mie scattering) of the particles.

Working Principle

At the very heart of the laser diffraction technique is the relationship between light and surfaces (which can be freely interchanged with "particle" for our purposes.) When light strikes a surface, it is either diffracted, refracted, reflected, absorbed. Diffraction is also known as "edge diffraction" as that is where it occurs. Refraction occurs as light changes angle travelling through the particle. We can obtain information about the size of a particle using the angle and intensity of scattered light. Diffracted and refracted light is useful for this purpose; absorbed and reflected light works against this purpose and must be taken into account during measurement and size calculation. HORIBA laser diffraction analysers use the Mie Scattering Solution by default and allow the user to input custom refractive index values.

Application

Particle size analysis is a very important test and is used for quality control in many different industries. In just about every industry where milling or grinding is used, particle size is a critical factor in determining the efficiency of manufacturing processes and performance of the final product. Industries and product types where particle sizing is used includes

- Pharmaceuticals
- Building materials
- Paints and coatings
- Food and beverages
- Aerosols

Specifications

Make	Horiba Japan
Model	LA-920
Range	20 nm to 2000 nm

Indicative price per sample

PKR 4,500/-

(Actual testing rates vary according to the type of sample and customer requirements)

For further queries or reservation of equipment for sample testing, please contact

Head of Materials Engineering Department
hodme@scme.nust.edu.pk
051-90855200/201

Dr Usman Liaqat
Assistant Professor, Department of Materials Engineering
usman.liaqat@scme.nust.edu.pk
051-90855223

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BET Surface Area and Porosity Analyser

INTRODUCTION

BET (Brunauer, Emmett and Teller) is used to measure the specific surface area of a sample including the pore size distribution. This information is used to predict the dissolution rate, as this rate is proportional to the specific surface area. Thus, the surface area can be used to predict properties of material.

Working Principle

The specific surface determined by BET relates to the total surface area (reactive surface) as all porous structures adsorb the small gas molecules. The surface area determined by BET is thus normally larger than the surface area determined by air permeability. The amount of adsorbed gas is correlated to the total surface area of the particles including pores in the surface. Traditionally Nitrogen is used as adsorbate gas. Gas adsorption also enables the determination of size and volume distribution of micropores (0.35 – 2.0 nm). The specific surface area of a powder is determined by physical adsorption of a gas on the surface of the solid and by calculating the amount of adsorbate gas corresponding to a monomolecular layer on the surface.

Application

Critical to the design and manufacture of solids, surface area analysis is one of the most widely used methods in material characterisation. Common applications in which knowledge of the surface area is critical include the production and further processing of carbon, pharmaceuticals, catalysts, batteries, ceramics, and minerals. The technique can be used to determine

- BET and Langmuir surface area
- Pore size distribution
- Pore volume
- Isothermal plot

Specifications

Make	Micromeritics
Model	Gemini VII2390t
Surface Area range	0.1m^2 or 0.01m^2/g
Pore volume	0.000004cm^3/g

Indicative price per sample

PKR 10,000/-

(Actual testing rates vary according to the type of sample and customer requirements)

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Head of Materials Engineering Department
hodme@scme.nust.edu.pk
051-90855200/201

Dr Usman Liaqat
Assistant Professor, Department of Materials Engineering
usman.liaqat@scme.nust.edu.pk
051-90855223

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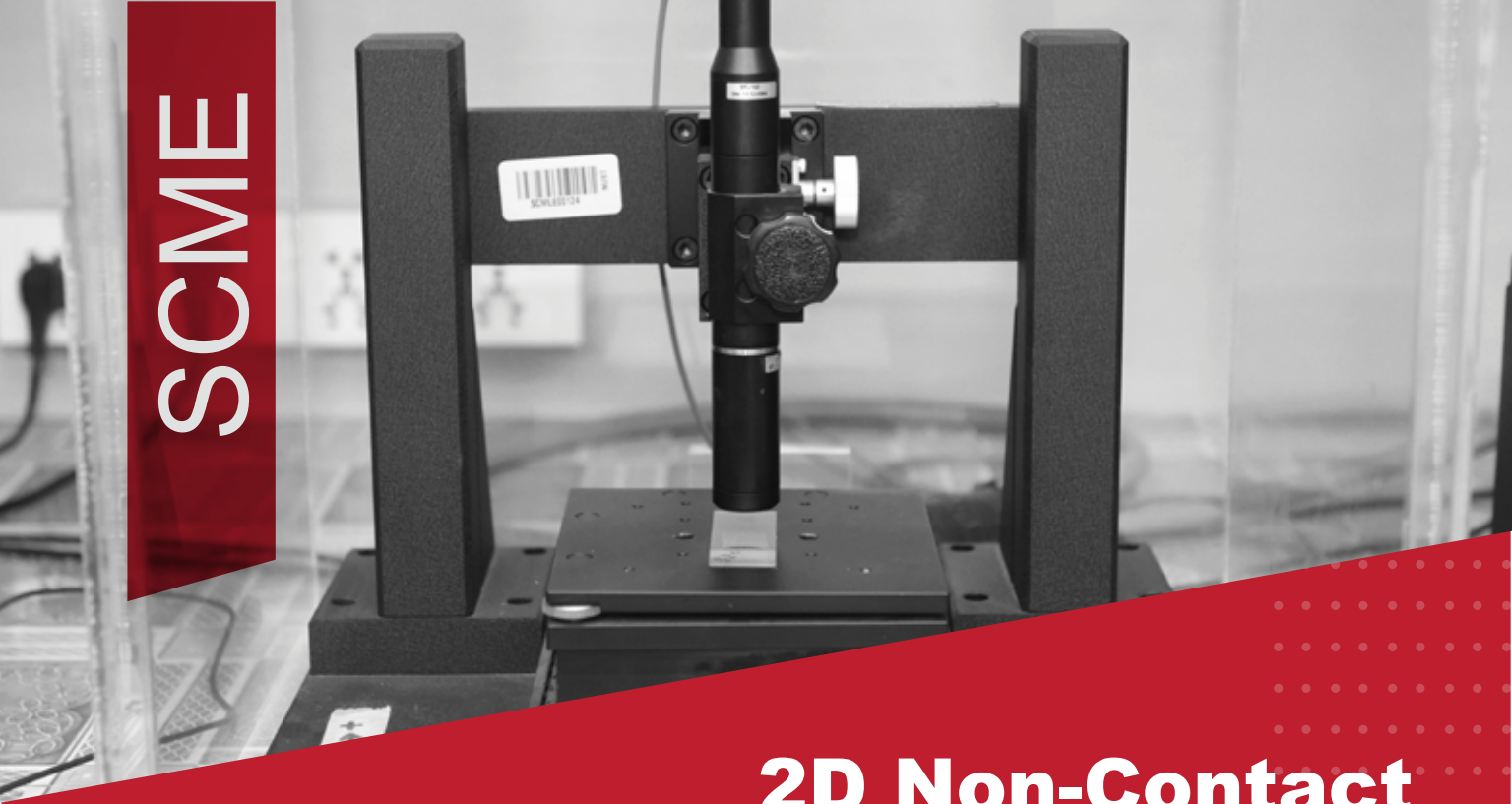

2D Non-Contact Profilometer

INTRODUCTION

A profilometer is a measuring instrument used to measure a surface's profile, in order to quantify its roughness. Critical dimensions as step, curvature, flatness is computed from the surface topography. This is the advanced compact profilometer gives the information about sample in a small and simple footprint. Optical profilometer is the ideal choice for the upgradation and the replacement of traditional stylus and laser profilometers.

Working Principle

Chromatic confocal techniques use white light that passes through a series of lenses with high degree of chromatic aberrations. Each wavelength will focus on the different distance creating the vertical measurement range. When the surface of the interest is within the measurement range a single wavelength of the white light will be in focus while all others will be out of focus. Advantages of optical profilometers are speed, reliability and spot size. For small steps and requirements to do 3D scanning, because the non-contact profilometer does not touch the surface the scan speeds are dictated by the light reflected from the surface and the speed of the acquisition electronics.

Application

- Understanding and quantifying a sample's surface is crucial for many quality control and research applications. It provides the information about
- 2D images of topography, roughness, step height/thickness
- Textiles /leather/paper
- Semiconductor/electronics/solar
- Paint and coating
- Biomedical devices
- Wear profile analysis for lubricant characterisation
- Characterisation of embossed structures and products
- Texture analysis for personal care products
- Scratch and crack analysis
- Paint and coating characterisation

Specifications

Make	NANOVEA, USA
Model	PS-50
Verticale Résolution	12 nm
X-Y Axis Resolution	0.1 µm
Working Temperature	At room temperature
X-Y Axis Travel	50 mm

Indicative price per sample

PKR 2,500/-

(Actual testing rates vary according to the type of sample and customer requirements)

For further queries or reservation of equipment for sample testing, please contact

Head of Materials Engineering Department
hodme@scme.nust.edu.pk
051-90855200/201

Dr Usman Liaqat
Assistant Professor, Department of Materials Engineering
usman.liaqat@scme.nust.edu.pk
051-90855223

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Raman Microscope and Analyser

INTRODUCTION

Raman is a non-destructive chemical analysis technique which provides detailed information about chemical structure, phase and polymorphy, crystallinity and molecular interactions. It is based upon the interaction of light with the chemical bonds within a material.

Working Principle

Raman spectroscopy relies upon inelastic scattering of photons, known as Raman scattering. A source of monochromatic light, usually from a laser in the visible, near infrared, or near ultraviolet range is used. The laser light interacts with molecular vibrations, phonons or other excitations in the system, resulting in the energy of the laser photons being shifted up or down. The shift in energy gives information about the vibrational modes in the system. A small number of these photons, approximately 1 photon in 10 million will scatter at a different frequency than the incident photon. This process is called inelastic scattering, or the Raman effect.

Application

Raman spectroscopy is used in chemistry to identify molecules and study chemical bonding and intramolecular bonds. Raman provides a fingerprint to identify molecules. Raman is also used to study the addition of a substrate to an enzyme. In solid-state physics, Raman spectroscopy is used to characterise materials, measure temperature, and find the crystallographic orientation of a sample. It is used in

- Art & archaeology
- Bioscience and medical diagnosis
- Education and teaching
- Forensic analysis
- Gemology
- Geology and mineralogy
- Materials science
- Pharmaceutical development and quality control
- Polymers and chemical processes
- Raman microscopy
- SERS (Surface-Enhanced Raman Spectroscopy)

Specifications

Make	**i-Raman®** High Resolution TE Cooled Fiber Optic Raman System, USA
Model	1064nm Fiber Optics
Laser	532 nm
Power	50 mW max
Range	150 cm-1 – 4000 cm-1
Resolution	~ 4.5 cm-1 at 614 nm
Laser Power Control	0-100 %

Indicative price per sample

PKR 2,000/-

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For further queries or reservation of equipment for sample testing, please contact

Head of Materials Engineering Department
hodme@scme.nust.edu.pk
051-90855200/201

Dr Aftab Akram
Assistant Professor, Department of Materials Engineering
aftabakram@scme.nust.edu.pk
051-90855215

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Differential Scanning Calorimetry (DSC)

INTRODUCTION

Differential Scanning Calorimetry is a fundamental tool in thermal analysis. Differential scanning calorimetry (DSC) is the most frequently used thermal analysis technique alongside TGA, TMA and DMA. DSC is used to measure enthalpy changes due to changes in the physical and chemical properties of a material as a function of temperature or time.

Working Principle

Differential Scanning Calorimetry is a thermal analysis technique that looks at how a material's heat capacity (Cp) is changed by temperature. A sample of known mass is heated or cooled and the changes in its heat capacity are tracked as changes in the heat flow. This allows the detection of transitions such as melts, glass transitions, phase changes, and curing. DSC enables the measurements of the transition such as the glass transition, melting, and crystallisation. Furthermore, the chemical reaction such as thermal curing, heat history, specific heat capacity, and purity analysis are also measurable. Recently, with the development of the highly functional polymeric material, the thermal properties analysis needs are increasing dramatically.

Application

Since most materials exhibit some sort of transitions when heated or cooled. DSC analysis is used for numerous applications in a wide range of industries. Examples include glass transition determination and the investigation of chemical reactions, melting and crystallisation behaviour. Other DSC applications deal with the influence of additives, fillers or the processing of materials. The characteristic shape of the individual DSC curves is used for quality control.
DSC is used in many industries, including the following

- Pharmaceuticals
- Polymers
- Food
- Paper
- Printing
- Manufacturing
- Agriculture
- Semiconductors
- Electronics

Specifications

Make	Perkin Elmer, USA
Model	DSC6000
Maximum Temperature	450°C
Minimum Temperature	-180°C
Scanning Rate	0.1°C/min to 100°C/min
Operating Atmosphere	Nitrogen

Indicative price per sample

PKR 5,500/-

(Actual testing rates vary according to the type of sample and customer requirements)

For further queries or reservation of equipment for sample testing, please contact

Head of Materials Engineering Department
hodme@scme.nust.edu.pk
051-90855200/201

Dr Zakir Hussain
Assistant Professor, Department of Materials Engineering
zakir.hussain@scme.nust.edu.pk
051-90855200

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Dead-End Filtration Cell

INTRODUCTION

The most basic form of filtration is dead-end filtration. The complete feed flow is forced through the membrane and the filtered matter is accumulated on the surface of the membrane. The dead-end filtration is a batch process as accumulated matter on the filter decreases the filtration capacity, due to clogging.

Working Principle

Membrane filtration can be a very efficient and economical way of separating components that are suspended or dissolved in a liquid. The membrane is a physical barrier that allows certain compounds to pass through, depending on their physical and/or chemical properties. Membranes commonly consist of a porous support layer with a thin dense layer on top that forms the actual membrane. The water is pushed through the membrane by pressure. All the water that is introduced in the dead-end-cell passes through as the permeate, the retained particles build up with time one the membrane surface results in an increased resistance to filtration and causes the permeate flux to decline.

Application

Dead-end filtration has most commonly been used for laboratory and medical filtration. The advantage of dead-end filtration is high product recovery and simple operation. Filtration module is used to test

- Membrane flux
- Permeation

Specifications

Make	Pakistan
Model	Customised Design
Body	Stainless Steel
Sample	Membrane
Liquid capacity	300 ml liquid
Sample diameter	2 inches
Solution used	Aqueous and non-aqueous solutions
Temperature	Pressure filtration at ambient temperatures

Indicative price per sample

PKR 2,500/-

(Actual testing rates vary according to the type of sample and customer requirements)

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Head of Materials Engineering Department
hodme@scme.nust.edu.pk
051-90855200/201

Dr Nasir Mehmood Ahmad
Assistant Professor, Department of Materials Engineering
nasir.ahmad@scme.nust.edu.pk
051-90855213

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Multiparameter Photometer

INTRODUCTION

The HI83399 benchtop photometer measures 40 different key water and wastewater quality parameters using 73 different methods that allow for multiple ranges and variations in chemistry for specific applications. The Chemical Oxygen Demand (COD) parameter is included for industrial and municipal wastewater treatment. The Calcium and Magnesium parameters included are beneficial to municipal wastewater treatment customers that need to monitor their water hardness chemicals removal process.

Working Principle

Absorption of light is a typical phenomenon of interaction between electromagnetic radiation and matter. When a light beam crosses a substance, some of the radiation may be absorbed by atoms, molecules, or crystal lattices. Photometers measure illuminance, irradiance, light absorption, scattering of light, reflection of light, fluorescence, phosphorescence, luminescence. Photometers detect the light with photoresistors, photodiodes or photomultipliers. To analyse the light, the photometer may measure the light after it has passed through a filter or through a monochromator for determination at defined wavelengths or for analysis of the spectral distribution of the light.

Application

Multiparameter Photometer is used for

- Determining the concentration of sodium and potassium ions in infusion solutions, such as NaCl solution, ringer solution or others
- Product control and indirect quality testing of various substances over sodium, potassium, or lithium
- Concentration determination in pharmaceutical reagents
- Water and wastewater treatment digestion parameters for COD, calcium, magnesium
- pH analysis
- Chemicals
- Soils
- Agriculture
- Pharmaceuticals
- Glass and ceramics
- Plant materials
- Water
- Microbiological laboratories
- Biological laboratories

Specifications

Make	HANNA Instrumnets®, Romania
Model	HI83399-2
Absorbance Resolution	0.001 Abs
Absorbance Range	0.000 to 4.000 Abs
Light Source	Light Emitting Diode
Light Detector	Silicon Photocell
Sample	Liquid

Indicative price per sample

PKR 2,500/-

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hodme@scme.nust.edu.pk
051-90855200/201

Dr Nasir Mehmood Ahmad
Assistant Professor, Department of Materials Engineering
nasir.ahmad@scme.nust.edu.pk
051-90855213

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SCI-100 Pro Digital Rotary Evaporator

INTRODUCTION

SCI-100 Pro Digital Rotary Evaporator is an essential instrument in chemical laboratories for the efficient and gentle removal of solvents from samples by evaporation. Vacuum system is necessary to accomplish whole procedure, select a suitable vacuum pump will efficiently improve the evaporation efficiency. It offers an excellent distilling solution in a wide range of applications.

Working Principle

The Digital Rotary Evaporator mechanically rotates a flask containing the compound in solution in a heated water bath. The solvent evaporates while the compound remains. The rotary evaporator principle is that the boiling points of liquids reduces on decreasing their pressure, allowing solvents to be vaporised at much lower temperatures than their boiling points at normal pressure. A condenser at the other end converts the gas back to liquid, which requires lowered temperatures. The evaporation vessel constantly rotates. This tactic aims to increase the surface area of the liquids. The centrifugal force keeps the liquid sticking to the inner surface of the vessel, exposing a larger surface area and causing faster evaporation.

Application

Digital Rotary Evaporator is an essential instrument in chemical laboratories for the efficient and gentle removal of solvents from samples by evaporation. It offers an excellent distilling solution in a wide range of applications. Higher efficiency, together with better accuracy, is the primary advantage of using a rotary evaporator over traditional distillation. In recent years, the application of rotary evaporator has been extended to the cooking industry. Molecular cooking is a science that applies the principles of chemistry and physics to cooking. Its applications include

- Evaporation
- Purification
- Carbon black modifications
- Membrane and carbon black adsorption studies

Specifications

Make	SCILOGEX -USA
Model	SCI-100
Speed Range	20-280 rpm
Heating Température Range	Room temp. to 180°C
Display	LCD (speed, temperature, time)
Power	1400 W
Sample	Liquid/solid in solution phase

Indicative price per sample

PKR 2,500/-

(Actual testing rates vary according to the type of sample and customer requirements)

For further queries or reservation of equipment for sample testing, please contact

Head of Materials Engineering Department
hodme@scme.nust.edu.pk
051-90855200/201

Dr Nasir Mehmood Ahmad
Assistant Professor, Department of Materials Engineering
nasir.ahmad@scme.nust.edu.pk
051-90855213

SCME

Polarised Optical Microscope (POM)

INTRODUCTION

Polarised light is a contrast-enhancing technique that improves the quality of the image obtained with birefringent materials when compared to other techniques such as darkfield and brightfield illumination, differential interference contrast, phase contrast, Hoffman modulation contrast, and fluorescence. Polarised light microscopes have a high degree of sensitivity and can be utilised for both quantitative and qualitative studies targeted at a wide range of anisotropic specimens.

Working Principle

In Polarising Optical Microscope (POM), a polariser intervenes between the light source and the sample. Thus, the polarised light source is converted into plane-polarised light before it hits the sample. This polarised light falls on a doubly refracting specimen which generates two wave components that are at right angles to each other. These two waves are called ordinary and extraordinary light rays. The waves pass through the specimen in different phases. They are then combined using constructive and destructive interference, by an analyser. This leads to the final generation of a high-contrast image.

Application

Polarised microscopy is primarily used in the field of geology or petrography for the study of rocks and minerals but has many other applications. Additional science fields that benefit from polarisation include medicine, chemistry, biology and metallurgy. Materials that can be examined under a polarised microscope include minerals, ceramics, polymers, wood, urea and numerous opaque and/or thick specimens. This technique finds application in several fields, such as

- Medicine
- Basic biology
- Industry (liquid crystals-based sensing devices, liquid crystal displays)
- Rock minerals

Specifications

Make	Nikon Eclipse Japan
Model	LV100N POL
Main Optics	Optical System: CF160 Infinity Coaxial coarse/ fine focus knob
Illumination	12 V-50 W halogen lamp, ND8 filters built-in, fly-eye lens. Diascopic/episcopic illumination
Focusing	Minimum reading in 1µm increments
Eye-piece	10 X (F.O.V.22mm)
Objective Magnification	CFI TU Plan Fluor EPI P 5X, P 10X, P 20X, P 50X
Tubes	P-TT3 trinocular and P-TB2 binocular tubes for polarizing microscopy, Bertrand lens built-in
Analyser	360°rotary dial, minimum reading angle 0.1°
Stage	Rotatable 360°, top grade circular graduated stage
Polariser	Fixed at bottom of condenser holder
Power Consumption	1.2A / 75W

Indicative price per sample

PKR 2,500/-

(Actual testing rates vary according to the type of sample and customer requirements)

For further queries or reservation of equipment for sample testing, please contact

Head of Materials Engineering Department
hodme@scme.nust.edu.pk
051-90855200/201

Dr Zakir Hussain
Assistant Professor, Department of Materials Engineering
zakir.hussain@scme.nust.edu.pk
051-90855200

SCME

Elemental Analyser (EA)

INTRODUCTION

Elemental Analyser is used for determination of carbon, hydrogen, nitrogen, sulphur and oxygen content in organic and other types of materials. Elemental analysis is a process where a sample of some material (e.g., soil, waste or drinking water, bodily fluids, minerals, chemical compounds) is analysed for its elemental and sometimes isotopic composition.

Working Principle

The sample is injected into a high temperature furnace and combusted in pure oxygen under static conditions. At the end of the combustion chamber, a dynamic burst of oxygen is added to ensure total combustion of all inorganic and organic substances. The resulting products such as carbon dioxide (CO_2), water (H_2O), sulphur dioxide (SO_2) and nitrogen (N_2) are used to determine amount of CHNS. Elemental analysis can be qualitative to determine what type of elements are present in a sample, and it can also be quantitative to determine how much of each element is present in analyte.

Application

Elemental Analyser applications areas include analysis of organic/inorganic chemicals, environmental, petrochemicals, catalysts, food industry and combustion or exhaust analysis. Some industries where elemental analyser is used include

- Environmental and consumer safety
- Steel and metal industry
- Petrochemical industry
- Pharmaceutical industry
- Cement industry
- Rubber industry
- Food industry
- Mining and geology
- Combustion or exhaust analysis

Specifications

Make	NC Technologies, Italy
Model	ECS 8020
Elements	CHNS-O
Furnace Temperature	Max 1100° C
Accuracy	<0.2%
Precision	< 0.1%
Sampler	Autosampler
Sample Size	500 mg
Sample Type	Liquid, Solid

Indicative price per sample

PKR 8,000/-

(Actual testing rates vary according to the type of sample and customer requirements)

For further queries or reservation of equipment for sample testing, please contact

Head of Chemical Engineering Department
hodche@scme.nust.edu.pk
051-90855103/105

Dr Salman Raza Naqvi
Assistant Professor, Department of Chemical Engineering
salman.raza@scme.nust.edu.pk
051- 90855123

SCME

Gas Chromatograph-Mass Spectrometer (GC-MS)

INTRODUCTION

Gas Chromatography Mass Spectrometry (GCMS) is a technique used for the qualitative and quantitative analysis of organic volatile and semi-volatile compounds. It is a hyphenated analytical technique that combines the separation properties of gas-liquid chromatography with the detection feature of mass spectrometry.

Working Principle

The GC-MS is composed of two major building blocks: the gas chromatograph and the mass spectrometer. The gas chromatograph utilises a capillary column whose properties regarding molecule separation depend on the column's dimensions (length, diameter, film thickness) as well as the phase properties. Helium is used as a transport gas or mobile phase and a capillary column is used as a stationary phase. The gas chromatograph separates the individual components of the samples on the basis of their retention time, whereas the mass spectrometer detects the eluent from chromatographic column by making characteristic fragmentation pattern of each component present in the sample.

Application

Gas Chromatography- Mass Spectrometry technique is used for qualitative and quantitative analysis of organic and inorganic samples finds its applications in diverse industries such as

- Explosives materials investigation
- Drug detection
- Food industry
- Petrochemical industry
- Pharmaceutical industry
- Polymer industry
- Environmental and consumer safety
- Combustion or exhaust analysis
- Fertilizer industry
- Rubber industry
- Mining and geology

Specifications

Make	Perkin Elmer, USA
Model	Clarus 500
GC Injector Temperature	Maximum 450° C
Oven Temperature programmer	3 ramp
Detector 1	Mass spectrometer (MS)
Detector 2	Flame ionisation detector (FID)
Source	Electron Ionisation
Mass range	1.0 to 1000 amu
Samples	Liquid or solids in the form of dilute solutions

Indicative price per sample

PKR 8,000/-

(Actual testing rates vary according to the type of sample and customer requirements)

For further queries or reservation of equipment for sample testing, please contact

Head of Chemical Engineering Department
hodche@scme.nust.edu.pk
051-90855103/105

Dr Tayyaba Noor
Associate Professor, Department of Chemical Engineering
tayyaba.noor@scme.nust.edu.pk
051-90855121

SCME

High Performance Liquid Chromatography (HPLC)

INTRODUCTION

High Performance Liquid Chromatography (HPLC) is an analytical chromatographic technique which is used to separate, identify and quantify the components present in a mixture. Liquid chromatography is a well-established technique for the separation of substances. HPLC can be used for both qualitative analysis as well as quantitative analysis.

Working Principle

The separation principle of HPLC is based on the distribution of the analyte (sample) between a mobile phase (eluent) and a stationary phase (packing material of the column.) Depending on the chemical structure of the analyte, the molecules are retarded while passing the stationary phase. The specific intermolecular interactions between the molecules of a sample and the packing material define their time “on-column.” Hence, different constituents of a sample are eluted at different times. Thereby, the separation of the sample ingredients is achieved on the basis of their retention time. The analyte which is present in solution phase is separated into individual components, so purification of an impure sample can also be performed.

Application

High Performance Liquid Chromatography is a non-destructive technique used for qualitative and quantitative analysis of organic and inorganic samples in various industries such as

- Pharmaceutical industry
- Energetic materials investigation
- Petrochemical industry
- Paint industry
- Forensics and drug detection
- Food industry
- Polymer industry
- Environmental and consumer safety
- Fertiliser industry
- Rubber industry
- Mining and geology

Specifications

Make	Perkin Elmer, USA
Model	Series 200 HPLC
Maximum Operating Pressure	6200 psi
Minimum Flow rate	0.1 ml/min
Minimum Flow rate	10 ml/min
Mobile Phase	Methanol, Water, Acetonitrile
Elution Mode	Gradient and Isocratic
Operating Temperature	Room temperature
Samples	Liquid and solids in solution phase

Indicative price per sample

PKR 4,000/-

(Actual testing rates vary according to the type of sample and customer requirements)

For further queries or reservation of equipment for sample testing, please contact

Head of Chemical Engineering Department
hodche@scme.nust.edu.pk
051-90855103/105

Dr Tayyaba Noor
Associate Professor, Department of Chemical Engineering
tayyaba.noor@scme.nust.edu.pk
051-90855121

SCME

Fourier Transform Infrared Spectrophotometer (FTIR)

INTRODUCTION

Fourier Transform Infrared Spectroscopy (FTIR) is an analytical technique which used for the qualitative analysis of compounds. FTIR is used to determine type of chemical bonds present in a sample by producing the infrared absorption spectrum that is like a molecular fingerprint of sample. It can also be used to identify functional groups and molecular structure of a material.

Working Principle

FTIR Analysis measures interaction of sample with the infrared region of the electromagnetic spectrum. When a sample is exposed to infrared radiations, the bonds between different elements absorb light at different frequencies due to their characteristic vibrational energy levels. The light absorbed or transmitted is measured using an infrared spectrometer which produces the output of an infrared spectrum.

Application

Fourier Transform Infrared Spectroscopic technique is widely used in analysis of samples for various industrial application such as

- Environmental and consumer safety
- Forensics and Drug detection
- Pharmaceutical Industry
- Energetic Materials Investigation
- Petrochemical Industry
- Paint Industry
- Food industry
- Polymer Industry
- Fertilizer Industry
- Rubber Industry
- Mining and Geology

Specifications

Make	Perkin Elmer, USA
Model	Spectrum 100
Frequency range	350-7800 cm^{-1}
Sample Holder Material	KBr Disc
Resolution	0.5 cm
Maximum Pressure limit of hydraulic press	15 ton
Mode	Absorption/ Transmittance
Operating Temperature	Room temperature
Samples	Liquid and solids

Indicative price per sample

PKR 1,700/-

(Actual testing rates vary according to the type of sample and customer requirements)

For further queries or reservation of equipment for sample testing, please contact

Head of Chemical Engineering Department
hodche@scme.nust.edu.pk
051-90855103/105

Dr Tayyaba Noor
Associate Professor, Department of Chemical Engineering
tayyaba.noor@scme.nust.edu.pk
051-90855121

SCME

Ultraviolet Visible Spectrophotometer (UV-Vis)

INTRODUCTION

Ultraviolet Visible Spectroscopy (UV-Vis) refers to absorption spectroscopy or reflectance spectroscopy in part of the ultraviolet and the adjacent visible spectral regions. It is an analytical technique that is used to measure the attenuation of a light beam after it passes through sample. This technique can be used both for the qualitative as well as quantitative analysis of compounds. The analyte is present is the form of a dilute solution.

Working Principle

Molecules containing bonding and non-bonding electrons can absorb energy in the form of ultraviolet or visible light to excite these electrons to higher anti-bonding molecular orbitals. The more easily excited the electrons (i.e. lower energy gap between the HOMO and the LUMO), the longer the wavelength of light it can absorb. The wavelength of maximum absorption is characteristic of a sample, so identification of unknown sample can be done and band gap of various materials can be calculated. The Beer-Lambert Law which is the linear relationship between absorbance and concentration of an absorbing species is validated for quantitative analysis. UV-Visible spectroscopy is a non-destructive characterisation technique.

Application

Applications areas of Ultraviolet Visible Spectroscopy include metals analysis, conjugated compounds analysis, petrochemical analysis, environmental analysis, food industry, drug detection, polymers industry, explosives investigation, combustion analysis and identification of unknown samples. Some of the industrial areas having applications of UV-visible spectroscopy are as below

- Paint industry
- Textile industry
- Petrochemical industry
- Energetic materials investigation
- Pharmaceutical industry
- Forensics and drug detection
- Food industry
- Polymer industry
- Environmental and consumer safety
- Fertiliser industry
- Rubber industry

Specifications

Make	Analytik Jena Germany
Model	SPECORD 200 Plus
Wavelength Range	190-1100 nm
Cuvette Material	Quartz
Lamp	Halogen Deuterium
Minimum Wavelength	190 nm
Maximum Wavelength	1100 nm
Bandwidth	1.4 nm
Scanning	Dual beam
Operating Temperature	Room temperature
Samples	Liquid/solids in solution phase

Indicative price per sample

PKR 1,000/-

(Actual testing rates vary according to the type of sample and customer requirements)

For further queries or reservation of equipment for sample testing, please contact

Head of Chemical Engineering Department
hodche@scme.nust.edu.pk
051-90855103/105

Dr Tayyaba Noor
Associate Professor, Department of Chemical Engineering
tayyaba.noor@scme.nust.edu.pk
051-90855121

SCME

Potentiostat

INTRODUCTION

A potentiostat is an electronic instrument that controls the voltage difference between a working electrode and a reference electrode. Both electrodes are contained in an electrochemical cell. The potentiostat implements this control by injecting current into the cell through an auxiliary, or counter, electrode.

Working Principle

The potentiostat measures the current flow between the working and counter electrodes. The controlled variable in a potentiostat is the cell potential and the measured variable is the cell current. A potentiostat requires an electrochemical cell with three electrodes. The working electrode is the electrode where the potential is controlled and where the current is measured. For electrochemical tests, the working electrode is an inert material such as gold, platinum, or glassy carbon. The reference electrode is used to measure the working electrode potential. Reference electrodes are the saturated calomel electrode (SCE) and the silver/silver chloride (Ag/AgCl) electrodes. The counter or auxiliary electrode is a conductor that completes the cell circuit. The counter electrode in lab cells is generally an inert conductor like platinum or graphite.

Application

A potentiostat/galvanostat finds its application to study diverse electrochemical processes using three electrode systems and investigations of various electrochemical phenomena. Common application areas are given below:

- Electronics industry
- Fuel cells testing
- Battery testing
- Corrosion studies
- Photovoltaic systems
- Supercapacitors
- Electrochemical impedance spectroscopy
- Chronoamperometry
- Cyclic voltammetry
- Electrogravimetry

Specifications

Make	Gamry, USA
Model	Interface 1010E
Max Applied Current	±1 Ampere
Maximum Applied Potential	±11 Volts
EIS Range	10 μHz - 2 MHz
Working Electrode	Glassy Carbon Electrode
Reference Electrode	Silver/Silver Chloride (Ag/AgCl)
Counter Electrode	Platinum wire
Operating Temperature	Room temperature
Samples	Liquid and solids

Indicative price per sample

PKR 2,000/-

(Actual testing rates vary according to the type of sample and customer requirements)

For further queries or reservation of equipment for sample testing, please contact

Head of Chemical Engineering Department
hodche@scme.nust.edu.pk
051-90855103/105

Dr Tayyaba Noor
Associate Professor, Department of Chemical Engineering
tayyaba.noor@scme.nust.edu.pk
051-90855121

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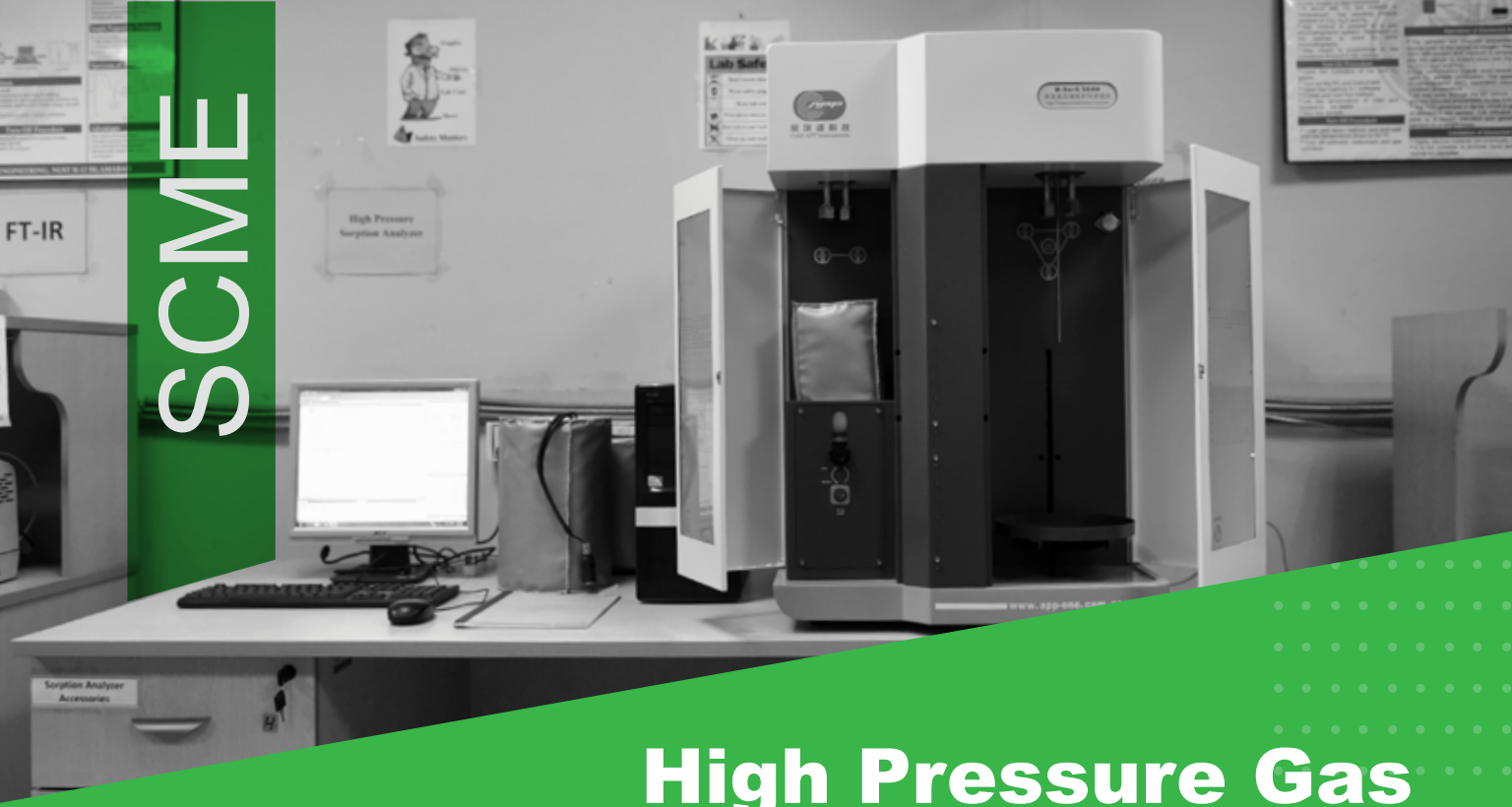

High Pressure Gas Adsorption Analyser

INTRODUCTION

The gravimetric or volumetric sorption technique is one of the most prevalent methods used to determine the amount and rate of the interaction of a gas or vapor with a material. The material can be a solid or liquid, and both thermodynamics and kinetics of the sorption process can be studied. Both static and dynamic modes can be used for vapors as well as gas species.

Working Principle

The sorption technique works by placing a sample onto a microbalance. The weight of the sample is measured continuously as a function of the applied temperature and pressure. In a characteristic isotherm measurement, the temperature is constant, and the gas pressure is controlled, but measurements can also be made in other more complex modes depending on the gas delivery/control system. Porous materials are generally degassed by being exposed to a vacuum and elevated temperature. This environment results in the desorption of the physisorbed and chemisorbed species. A typical sorption measurement has four stages:

- The sample is loaded into the analyser
- In-situ degassing and activation are performed, if required
- Gas pressure is applied at programmed values
- Sorption uptake is determined from the measured weight changes

Application

Sorption analysers are widely regarded as the benchmark for gravimetric or volumetric sorption analysers and are used in an extensive range of applications such as moisture and organic vapor sorption, thermodynamic and kinetic studies, gas sorption capacity determination in both academic and industrial laboratories. Some of the industrial and academic applications of sorption analyser are as below:

- Carbon capture
- Hydrogen storage
- Temperature programme adsorption
- Temperature programme desorption
- Kinetic studies
- Langmuir model regression isotherm
- Chemisorption/physisorption
- Diffusion coefficient determination
- Porosity and surface area

Specifications

Make	Gold APP Instruments, China
Model	H-Sorb 2600
Measurement Mode	Adsorption/desorption isotherms
Pressure Range	Atmospheric to 200 Bar
Temperature Range	Atmospheric to 500°C
Kinetic Isotherms	Langmuir Model Regression Isotherm
Desorption Mode	TPD (Temperature Programmed Desorption)
Adsorption Mode	Gibbs Supercritical Adsorption Measurement
Data Analysis	PCT (Pressure-Composition-Temperature)
Samples	Solids

Indicative price per sample

PKR 10,000/-

(Actual testing rates vary according to the type of sample and customer requirements)

For further queries or reservation of equipment for sample testing, please contact

Head of Chemical Engineering Department
hodche@scme.nust.edu.pk
051-90855103/105

Dr Tayyaba Noor
Associate Professor, Department of Chemical Engineering
tayyaba.noor@scme.nust.edu.pk
051-90855121

SCME

Total Base Number Analyser

INTRODUCTION

The potentiometric titrator is a versatile all-rounder that can control up to 12 burets. Smart End Point Detection for automatic parameter determination. It can be used to find the total base number. Total Base Number (TBN) is a measure of alkaline concentration present in a lubricant. Engine oils are formulated with alkaline additives in order to combat the build-up of acids in a lubricant as it breaks down.

Working Principle

This equipment works on the principle of titration of acids and bases using solvents. The sample is dissolved in an essentially anhydrous mixture of chlorobenzene and glacial acetic acid and titrated with a solution of perchloric acid in glacial acetic acid using potentiometric titrimeter. A glass indicating electrode and a reference electrode are used, the latter being connected with the sample solution by means of a salt bridge. The meter readings are plotted against the respective volumes of titrating solution, and the end point is taken at the inflection in the resulting curve. The unique first variable refilling function allows refilling of burettes prior to becoming empty, so that the units can run without suspending a titration near the end point. The results, data, and titration curves can be printed via available printer.

Application

New and used petroleum products can contain basic and acidic constituents that are present as additives. The relative amounts of these materials can be determined by titration with acids and bases respectively. The base number is a measure of the amount of basic substance in the oil, always under the conditions of the test. It is sometimes used as a measure of lubricant degradation in service; however, any condemning limits must be empirically established. Following oils can be tested using this equipment

- Petroleum products
- Biodiesel
- Blends of biodiesel
- Gasoline engine oil
- Lubricant oil
- Kerosene oil
- Diesel oil

Specifications

Make	Mitsubishi Japan
Model	GT-200 Automatic Titrator
Titration Types	Potentiometric titration (Neutralisation, oxidation-reduction, chelate, precipitation)
Titration (Optional)	Polarisation and conductivity titrations can be run by adding analogue pack PS
Detection Ranges	pH : 0 to 14.00 mV : -2000 to +2000mV µA : 0 to 20
Electrodes	Reference Electrode Sleeve Type, Glass Electrode
Titration Mode	INF
ASTM	D-664 D-2896
Combination Titration	Set Two Titration Files
Glass Electrode, pH	0 to 11
Reference Electrode Solution	Lithium Chloride in Ethanol

Indicative price per sample

PKR 4,000/-

(Actual testing rates vary according to the type of sample and customer requirements)

For further queries or reservation of equipment for sample testing, please contact

Head of Chemical Engineering Department
hodche@scme.nust.edu.pk
051-90855103/105

Dr Zaib Jahan
Assistant Professor, Department of Chemical Engineering
zaibjahan@scme.nust.edu.pk
051-90855080

nust.edu.pk

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Islamabad, Pakistan

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