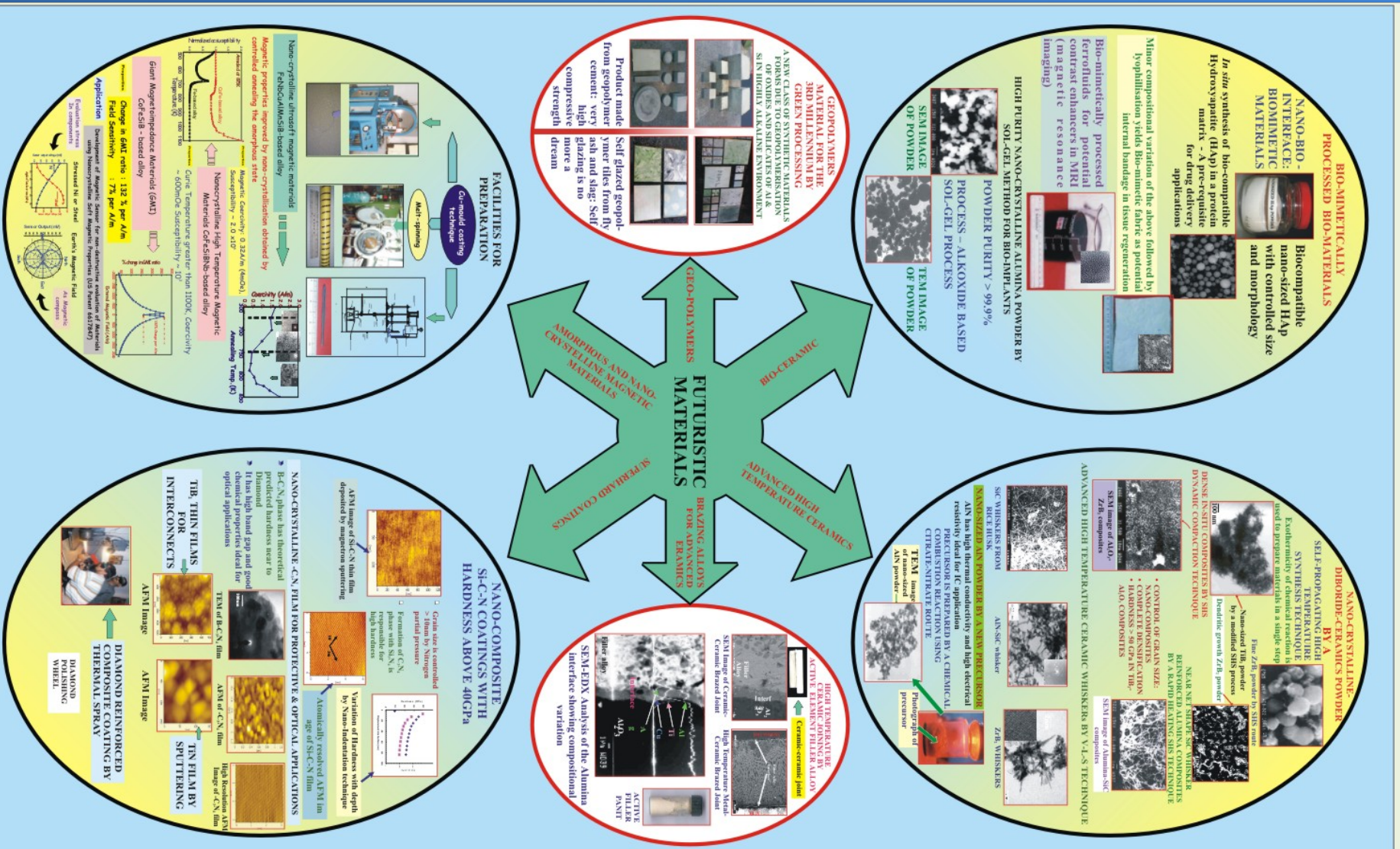


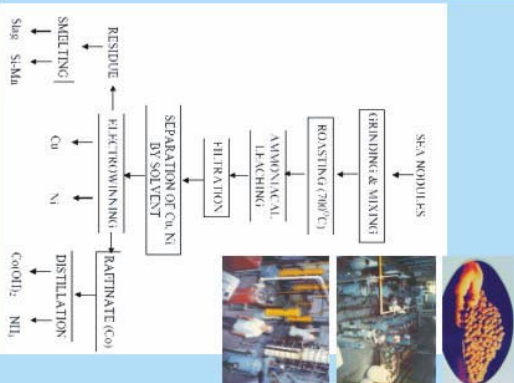
Fuelling change in industry



Alternative route to metal extraction from primary sources

Metals from Sea Nodules

NML developed technology for recovery of Cu, Ni & Co from deep sea manganese nodules using Reduction roast-Ammonia leaching-SX-EW route & manganese from residue as Si-Mn by smelting route.



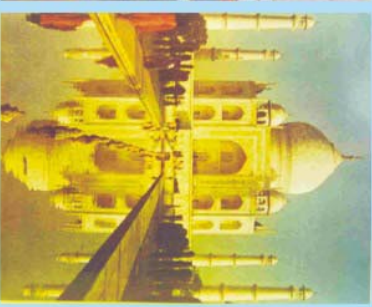
Metal Extraction through Biological action on Ores

Bioleaching-a potential tool to recover metals from low-grade & waste materials. It is an energy efficient & environmental friendly process



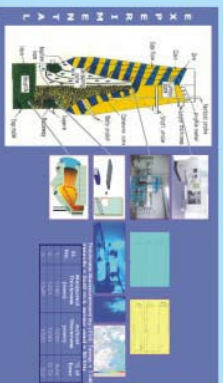
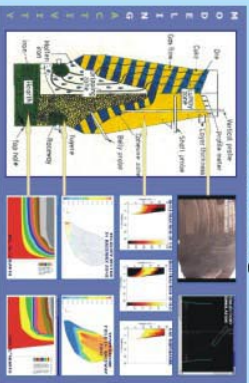
Bioprocessing Methods Developed:

- 98% U EXTRACTION FROM A LEAN ORE WITH 7T IN 15 DAYS
- Above 95% RECOVERY OF Cu, Ni & Co FROM NODULES BY *Aspergillus niger*



NML's ecofriendly cupola technology aims to improve the quality of environment around the Taj Trapexium and prevent degradation of the Taj Mahal

Iron Making BF Modelling



MAGNESIUM

Extraction Of Magnesium From Indigenous Raw Materials



The technology was transferred to M/S SMCL, Andhra Pradesh. They have commissioned a plant based on the above technology to produce 600t/yr. They are the sole producers of Mg in the country.



Low shaft furnace technology transferred to: Polybond Insulation pvt. ltd



Fuelling change in industry



Combating corrosion

Value Additions

Chrome T - a superior pigment converting carcinogenic Cr (VI) to harmless Cr (III)



Stainless Steel Powder

using simple sensitization principles to produce flaky SS powder for coatings, sintered products, etc

Nano Alumina Powders by sol gel technique -

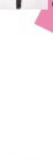
An array of combating tools

NML-vapour phase inhibitors: protects metals in transport



NML

inhibitors :
reduce losses in galvanising/ picking



Cost effective



Sacrificial Anodes :
for ship hulls, underground pipes, harbour structures

Assessing & Protecting

Evaluating concrete corrosion - assessing rebars for infrastructures



Low temperature sensitization in SS



- critical for nuclear power plants



Facilities

- * Raman Spectroscope
- * FTIR Spectrometer
- * Array of automated potentiostats
- * Impedance analysis
- * Humidity chamber

Image Analyser



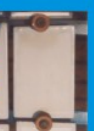
AAS



Enhancing Component Life

Services

- * A variety of ASTM and NACE specified corrosion tests
- * We specialize in
 - Atmospheric corrosion
 - Concrete corrosion
 - Hydrogen cracking
 - Pitting
 - Sensitization
- * Root cause corrosion failure analysis
- * Life prediction of critical corroding components



* Atmospheric corrosion exposure facilities

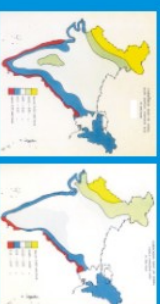
* Atomic absorption spectroscopy

* Constant load proof rings

UV Visible Spectrophotometry



History
The first laboratory to initiate the idea of a "Corrosion Map of India" - a concept far ahead of its time



Most significant contributions in understanding the high corrosion resistance of the Delhi Iron Pillar



NML recognized for outstanding corrosion related research in India in 2005 by The NACE India section

Protecting Critical Structures

Service to the Nation

CSIR-NML

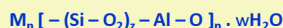
Geopolymer

New generation green material

Fuelling change in industry

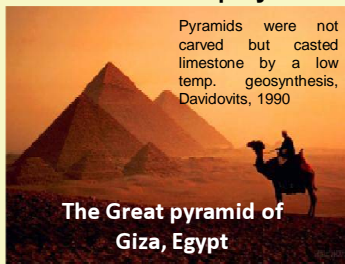
What is Geopolymer

artificial rocks formed at low temperature by chemical reactions between various aluminosilicate oxides and silicates under highly alkaline conditions and yielding polymeric Si-O-Al-O bonds. Geopolymers can be described by the general formula:

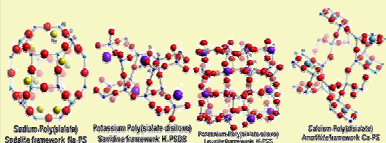


M is alkaline element, 'z' is presence of a bond, z is 1, 2 or 3, and n is degree of polymerization

The First Geopolymer



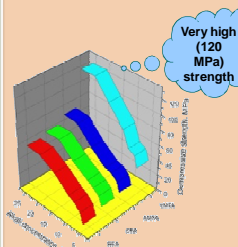
Structure of Geopolymer



Depending upon SiO_2 to Al_2O_3 ratio, Geopolymer structure tends to change and the character changes from rigid 3D network (Si:Al ratio 1,2,3) to more polymeric 2D structure (Si:Al ratio > 15)

New Developments

Ultra High Strength Geopolymer Cement

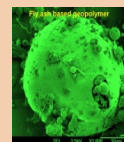


Ready to use in 6-8 hours. Can be used in critical structures where high strength in short time is required such as runway repairing, dams, highway, construction, etc

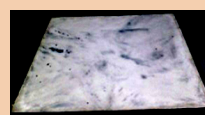


Self Glazed Geopolymer Tiles

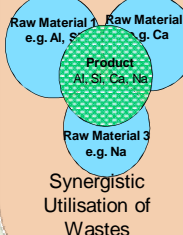
- ❖ Low temperature requirement (<100 °C)
- ❖ Low energy consumption and no emissions
- ❖ No additional glazing material required
- ❖ Different colours and design
- ❖ Properties at par with commercial tiles



Slag addition can do wonders



Pavement Blocks



- ❖ Co-geopolymerisation of fly ash, BF slag and red mud.
- ❖ Ambient temperature processing
- ❖ Ready to use in 7 days



Facilities

- ❖ Temperature and humidity controlled geopolymer lab
- ❖ Processing facilities such as curing chamber, humidity cabinet, driers, etc
- ❖ High energy mills such as attrition mills, vibratory mills, jet mill, planetary mill, etc.
- ❖ Particulate characterization facility such as laser particle size analyser, zeta potential, conduction calorimeter, specific surface area, etc
- ❖ Characterization facilities such as SEM, TEM, XRD, XFF, TG/DTA, FTIR etc.

Ongoing Activities

Focus on Industrial Wastes

- ❖ Use of bauxite residues, red mud and red sand in geopolymer concrete
- ❖ Tailoring structure and properties of geopolymer products by controlling reactivity and chemistry
- ❖ Use of waste such as demolition waste, marble slurry, zinc slag etc for making quality geopolymer products
- ❖ Immobilization of toxic metals in geopolymer matrix
- ❖ Efforts towards setting up of a pilot plant for making pavement blocks from fly ash

For further details, contact

Director
National Metallurgical Laboratory
(NML), Jamshedpur, India
831 007, India

Email: director@nmlindia.org
Website: www.nmlindia.org



CSIR-NML

Service to the Nation



Building Technologies

IMPROVED BRICK PRODUCTION TECHNOLOGIES

Processing of Clay

- ◆ Characterisation and Testing of Clay
- ◆ Mix composition for inferior soils
- ◆ Use of flyash, rice-husk ash, grog, stone dust.
- ◆ Removal of kankar/ nodules by ghol process



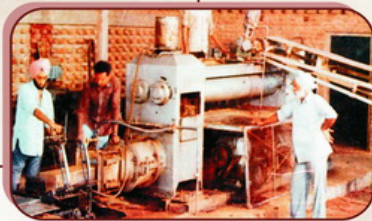
Brick Moulding Table

- ◆ Well Shaped and dimensionally accurate bricks
- ◆ Simple and easy, can be operated by unskilled labour and women
- ◆ 1000 to 1200 Bricks per day
- ◆ No power required
- ◆ Can be fabricated locally



Brick Extrusion Machine

- ◆ Production Capacity : 2500 bricks/hour
- ◆ Power required: 50 KW
- ◆ Bricks of high strength and low water absorption
- ◆ Suitable for making :
 - Perforated bricks ● circular half bricks
 - Paving bricks/tiles ● Split tiles ● Canal lining tiles



Drying Of Bricks

Extruded Bricks dried under shade to avoid warping and shrinkage cracks



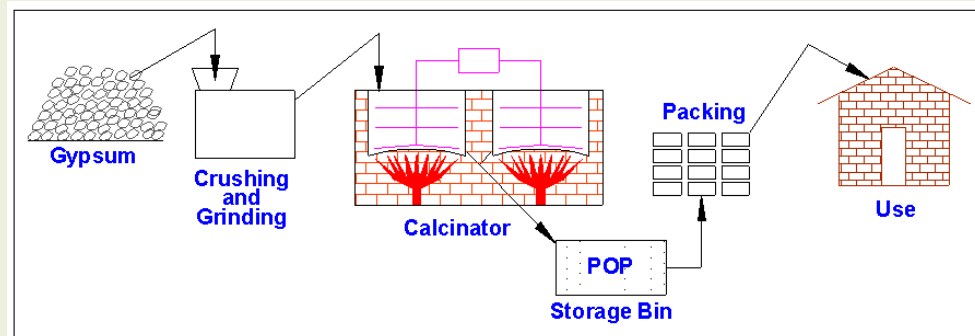
- Improved Quality of finished product
- Saving in fuel consumption (upto 30%) in firing

CSIR-CBRI

Service to the Nation



Energy Efficient Gypsum Calcinator

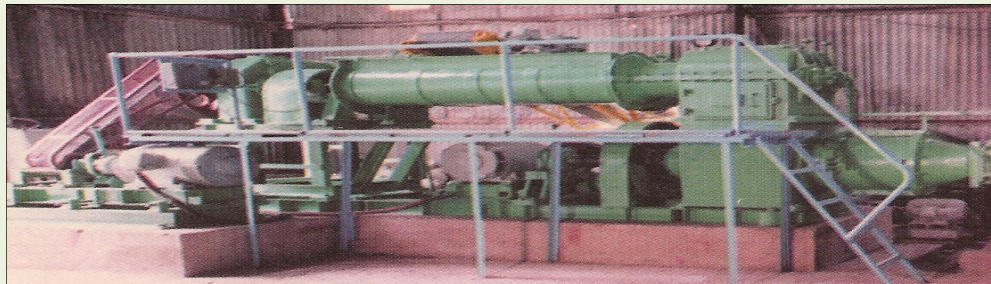


Conversion of Gypsum into plaster of Paris

Salient Features

- Uniform quality of Plaster
- Suitable for calcining quarry, marine, phosphogypsum
- Suitable for producing building, pottery / ceramic, surgical grade plasters.
- Eco- friendly and pollution free system
- High Thermal Efficiency 70-80%
- Flexibility for using solid / liquid / gaseous fuels
- Plant & machinery: Indigenous
- Basic module of capacity 8 TPD & 20 TPD (3 shifts)

Bricks Making Machine (By Extrusion Process)



For making Building Bricks and Other Structural Products

Salient Features

- High proportion of flyash can be used
- Uniform size and superior strength bricks with low porosity produced
- Fuel saving upto 30%
- Environment friendly
- Flyash addition 25 to 40% (w/w) to the soil mass.
- Power requirement: 100 KW
- Plant & machinery: Indigenous
- Plant capacity: 4000 bricks per hour



For making Lime / Cement bricks

Salient Features

- Portable type machine
- Produce bricks of good dimensional stability
- Easy in operation and maintenance
- No special measures are required
- Produce four bricks of conventional size at a time.
- Works on Vibro-Compaction principle
- Plant & machinery: Indigenous
- 3000 bricks per 8 hours shift.



Pine Needle Composites



Salient Features

- Huge Availability in western part of Himalayas
- Easily laminated/ painted
- Fire resistant
- Environment friendly
- Boards made with processed pine needles and new type of adhesive
- Meets requirements of IS: 3087

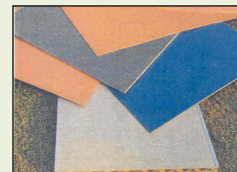
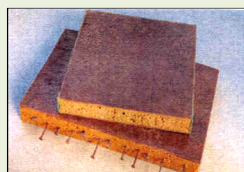
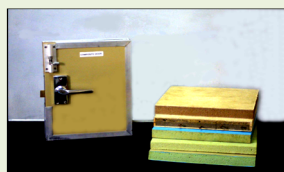
Geopolymer Bonded Bricks



Salient Features

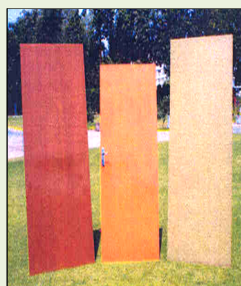
- Size : 23 x 11.5 x 7.5 cm
- Dry weight : 2.8 kg
- Compressive strength : 15-28 Mpa
- Water absorption : 8 -10%
- High strength & Low water absorption
- Fire resistant
- Acid and chloride resistant
- environment friendly
- Bricks made from geopolymerisation of fly ash / mine tailing wastes.
- Cured under ambient/ thermal conditions.
- Jointing with ordinary cement mortar
- Cost comparable with other fly ash bricks

Panels and Door Shutters



Salient Features

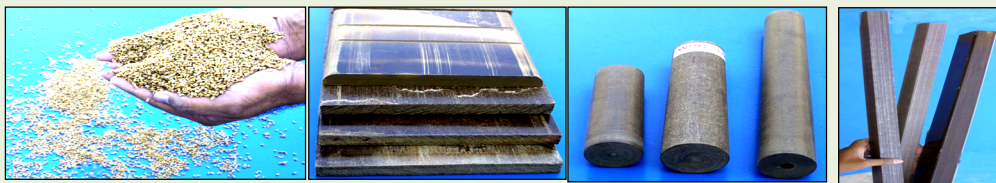
- Made from natural fibre laminate face & plastics wood core.
- Fire resistant, Termite proof & Environment friendly
- Dimensionally Stable.
- No additional wooden inserts required for door fixtures.
- Screw withdrawal load of door panels is ~ 150 kg against > 100 kg for wood.
- Conform to IS: 2202 when tested as per IS: 4020.
- Belongs to class I termite category and ~ 1% weight loss under natural decay.
- Weight : 12-14 Kg/m² for 35 mm thickness.
- Production capacity : 6000 doors /annum using 2-3 daylight press.
- Indian Patent 195175.



CSIR-CBRI



Rice Husk Plastic Wood



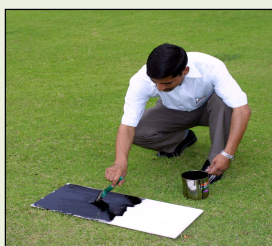
Salient Features

- As a replacement of natural wood.
- Termite resistant & environment friendly
- Use : Door & window frames, profile/sheets, lumber, fencing, decking, pelmet, furniture, structural support etc.
- Wood like surface appearance and can be shaped by conventional wood working tool.

- Production capacity : ~ 100 kg/hr for compounding and 10-20 m/hr for profile
- Moisture resistant : 2-3 % weight gain after 3 months exposure in immersed water.
- Meet safe permissible stress of structural wood as per NBC 2005, Sec 3, Timber

CSIR-CBRI

Bitumen Polymer waterproofing system



Salient Features

- Cold applied system
- Water Proofing
- Fire resistant
- Short curing cycle, good storage stability, low moisture vapour transmission, good adhesion to the substrate
- Functionally superior in terms of flexibility at lower temperature and stiffness at higher temperature compared to base bitumen
- Covering capacity ~300 gm/m²
- Felt prepared from bitumen polymer and non woven polyester fabrics meets IS:1322

Property	Parent	Network
Softening point (°C) (IS: 1205)	72.50	85.30
Penetration (dmm) (IS: 1203)	11.80	10.80
Tg (°C)	-9.63	-16.64
MVT (g/24h/m ²) (ASTM E 96)	16.95	6.78
Water penetration (IS: 5310)	No seepage	No seepage
Flow (%) (IS: 1834)	5	3.80
Extensibility (%) (IS: 1834)	6	12
Elastic recovery (%) (IS: 1208)	--	36
Adhesion to the substrate % (wet condition) (ASTM D 3409)	--	82

- Roofing composition made from maleated bitumen, recycled plastic wastes and other additives
- Production capacity : 2 ton/day

CSIR-CBRI

Impregnated grade Coal tar pitch

Salient Features

The process involves state of art technology to remove QI particles from the coal tar pitch without filtration or centrifugation techniques.

Applications

Extensively used for the densification of graphite electrodes & anodes, C-C composites and other carbon products

Used as an excellent precursor for advanced carbon products like Pitch-based carbon fibers,

High density - high strength - isotropic graphite,

Supreme quality needle coke, Matrix of C-C composites

Status of Commercialization

TURNOVER: Rs. 12 Crore/Annum; Licensee: M/s Konark Tar Products Pvt Ltd, Durgapur



CSIR-NPL

Green Mineral Cementation Technology

Alumina refinery and coal fired power plants generate huge amount of solid waste in the form of red mud and fly ash, which not only pose problem for disposal but also cause pollution of the natural water system. It is necessary to find safe and high volume use of these solid waste materials which can be only done through production of building materials that are economically affordable and environmentally safe.



Moorum-Clay



Gypsum-Slag



Clay-Sand brick

Mineral cementation is an innovative green chemistry of making cementing phases by chemical reaction of silica, alumina, calcium, magnesium, iron, alkali, sulphate bearing minerals under atmospheric condition. The mineral cementation phases develop binding property like hydraulic Portland cement which makes it suitable in manufacture of cold setting building materials. The process has been adopted to utilize various industrial and mining wastes in production of building materials such as brick, block and concrete.



Bricks from Red Mud



Fly ash



Brick (80% Fly ash)



Block (60% Fly ash)



Ancillary Units of M/s Vedanta Aluminium Limited

CSIR-IMMT

Service to the Nation

Waste to Wealth



RECYCLING AND REUSE OF ELECTRONIC WASTE

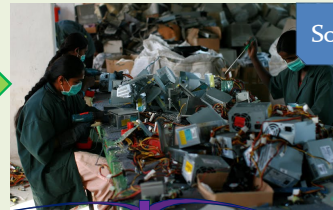
E-waste is one of the fastest growing waste streams in our country. E-waste is hazardous but a good source of metals, reusable plastics and glass. The volume of this waste generated today poses a great problem in terms of storage/disposal space and handling. Basically e-waste contains materials such as metals, glass and plastics. The demand for metals from rapidly growing economies especially India, China, Brazil will push the e-waste recycling market. The recovery of plastics, glass and metals from e-waste is a profitable business, which results in trans-boundary, and local e-waste trade.

Waste to Wealth

Electronic waste



Sorting of raw materials



Metals



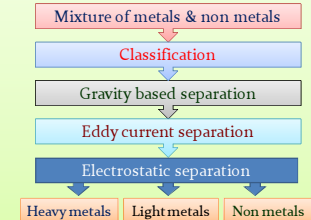
Plastics



Glass



PHYSICAL SEPARATION OF METALS



Metal rich concentration

HYDRO-PYRO-ELECTRO PROCESSING

- > Leaching
- > Cementation
- > Ion exchange
- > Solvent Extraction
- > Electro winning
- > Precipitation
- > Smelting

Metal extraction process



Metals

- ❖ Copper
- ❖ Lead
- ❖ Tin
- ❖ Zinc
- ❖ Iron
- ❖ Aluminum
- ❖ Gold
- ❖ Silver
- ❖ Platinum
- ❖ Tantalum

Direct recycle



Processing of plastic



New products



Processing of glass



New glass panels



Recovery of lead



New lead bars

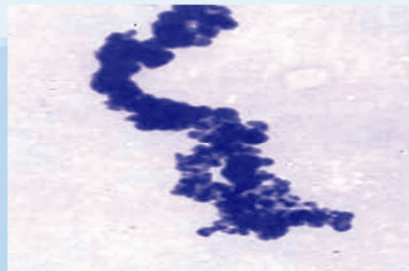


CSIR-NML

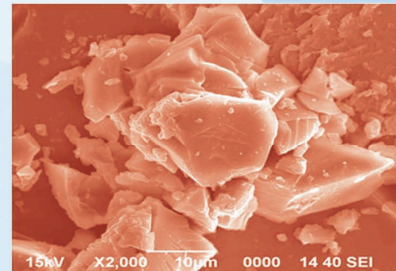
E-waste

CARBON BLACK : SUITABLE FOR RUBBER AND TYRE, INK AND PAINT INDUSTRIES, CHARACTERISTICS ARE SIMILAR TO HAF GRADE.

HUMID ACID FROM NON-CAKING COALS : SUITABLE FOR REMOVAL OF TOXIC ELEMENTS FROM EFFLUENTS AND CAN BE UTILISED FOR SOIL CONDITIONING.



Carbon Black



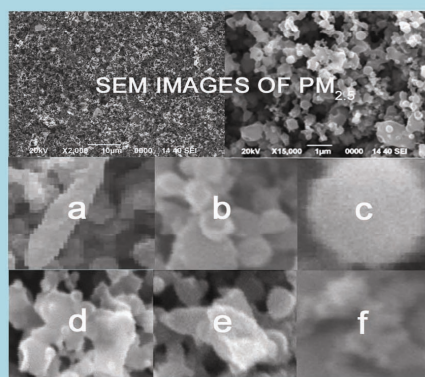
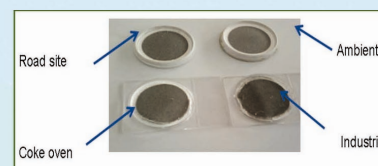
Humid Acid

Processes developed for mining sector

- MANAGEMENT OF ACID MINE DRAINAGE (AMD) BYCHEMICAL AND BIOLOGICAL PROCESSES, ALSO SUITABLE FOR CONTAINMENT OF PHTES (BIO AVAILABILITY OF POTENTIALLY HAZARDOUS TRACE ELEMENTS).
- INHIBITION OF PYRITE OXIDATION IN AMD FORMATION
- BIO REMEDIATION OF MINE WASTES

EMISSION STUDIES

- A. FROM COKE OVENS USING NE COALS AND BACKGROUND LEVELS
- B. PARTICLE TYPES & MARPHOLOGY



1. Regular and round shaped particles:

These particles are smaller in size ($0.1 \mu\text{m}$ to $0.3 \mu\text{m}$), due to the soot particles released during the coal utilization.

2. Irregular shaped particles:

These particles ($> 1 \mu\text{m}$) are due to the inorganic compounds and mineral matter released during the coal carbonization.

Melted mineral particles, b & c. Coal fly ash, d & e. Mineral particles, f. Soot aggregates

Sulphur concentrations in COGs, emission and emission rates of SO_2 for coke oven

S_R (%)	Retention in Coke	Concentration in COG (KgS/m^3)	Emission factor (Kg/t)	Emission rate t/y
2	40%	0.0024	2.4	613
	80%	0.008	0.8	204
4	40%	0.0048	4.8	1226
	80%	0.0016	1.6	409

For details please refer NEIST websites
www.neist.res.in & www.rrl.jorhat.com



Scratch-resistant, and antireflective (AR) coatings on plastic and glass substrates

Scratch-Resistant Coatings

Plastic materials are soft in nature, so prone to scratches or damages. For this reason transparent hard-coatings are necessary to improve its long life, quality and appearance. CGCRI has developed hard-coatings on plastic (CR-39, PC, PP etc.) ophthalmic lenses and sheets based on inorganic-organic hybrid nanocomposites

Photos of Plastic (CR-39®) ophthalmic lenses with hard coating



Hard coated 600 mm x 600 mm polycarbonate (PC) sheet



Salient features

- Coatings passed international tests required for commercial application such as
 - *Cross cut adhesive tape test (class 5B; ASTM D 3359)
 - *Pencil hardness value >6H (CR-39®) and 4H (PC); ASTM D 3363
 - *Abrasion test and steel wool test
 - *Chemical durability and Thermal test
- No. of Licensees: 2
 - *M/s Advanced Surface Technologies (AST), Gurgaon
 - *M/s Kumar Polylenes, Mohali
- Present status:
 - Advanced Surface Technologies is now producing hard coatings on CR-39 lenses and selling the sols (lacquer) to other plastic ophthalmic lens companies with full customer's satisfaction.

References

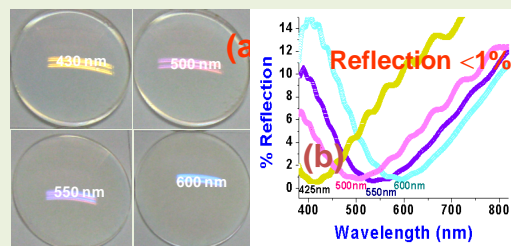
- S. K. Medda and G. De, *Ind. & Eng. Chem. Res.* 2009, 48, 4326.
- G. De and S. K. Medda, *Ind. Pat. No.* 196846, 2003.
- G. De, D. Kundu and S. K. Medda, *Ind. Pat. No.* 202349, 2003.

AR coatings

1. AR coatings on plastic ophthalmic lenses

Optical quality plastics transmit 88-91 % of visible light. To increase this transmission >98% or reduce reflection <1%, AR coatings are required.

(a) Photos of AR-coated CR-39® plastic lenses showing tunable reflection colours and (b) the corresponding % reflection curves



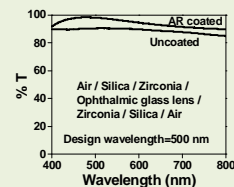
Salient features

- Coatings passed several international tests required for commercial application such as
 - > Passed cross cut adhesive tape test (class 5B)
 - > Pencil hardness value 5H and passed abrasion test
 - > Passed chemical durability test and thermal test
- Reflection colour of the AR coating can be tuned according to optical design
- Process is also ready for commercialization.

Reference

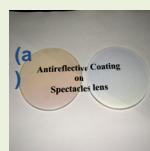
G. De, S. K. Medda and S. De, *Ind. Pat. Application No.* 1898Del/09, 2009.

2. AR coating on ophthalmic glass lens



Salient features

- Ophthalmic glass lens with (2 + 2 design based) sol-gel AR coating
 - ~100% transmission at design wavelength (say, 500 nm)
 - Excellent chemical and mechanical durability and coated glass lens can be used continuously for >5 years without any surface damage
 - Washing with liquid detergent does not affect the surface as the coatings are as good as glass
 - Technology transferred to BEL, Taloja and Advanced Surface Technology (AST), Gurgaon
 - Technology commercialized by Advanced Surface Technology (AST), Gurgaon.



(a) AR coated ophthalmic lenses of different aesthetic colours and (b) spectacles of AR coated glass lenses

- Reference: 1. P. K. Biswas, A. K. Atta and D. Ganguli, *Ind. Pat. No.* 186784, 1993.
2. P. K. Biswas, A. K. Atta and D. Ganguli, *Kodakikanal Obs. Bull.*, 1992, 11, 77



Wear Resistant Ceramic Tiles

Background: Industrial material handling equipments used for transport of highly erosive & abrasive media particle undergoes

- Heavy erosion & abrasion by mechanical process
- Corrosion by chemical process
- Essential to provide a cost effective solution to such wear problem

Why Ceramics? Remarkable resistance to both sliding & impact abrasion.

- ❑ Exceptionally tough & harder than tool steel
- ❑ Extraordinary durability
- ❑ Low friction coefficient
- ❑ Outlasts metal from ten to fifteen times

Recognized Materials :

Boron carbide, Silicon nitride, SiAlON

Alumina(85%), Fused cast, Basalt, AZS

Sequential order of erosion rate:

Boron carbide < Silicon nitride < Sialon < Alumina < AZS < Basalt

Most Cost Effective Material

ALUMINA FAMILY (85-95% Al_2O_3)






Recent Development

Fly Ash Based Material

(Replacing Alumina 10-40%)

Properties	Fly Ash Based			Alumina Based
Fly Ash	10%	20%	40%	Al_2O_3 85%
B.D., g/cc	3.38	2.85	2.75	3.47
A.P. (%)	0.8	0.5	0.3	0.3
Moh's hardness	9.0	9.0	~ 9	9.0
Comp. strength (kg/cm ²)	>10000	>10000	>10000	>10000
Abradability index	6.17	14.10	19.04	16.72
Erosion rate (vol. loss, cc/kg erodent)	0.0135	0.0151	0.0162	0.0155
Phase	Mullite, Corundum	Mullite, Corundum	Mullite, Corundum	Corundum, Mullite,

AREAS OF APPLICATION

I Thermal Plants		Pulverized coal bend pipes, Fan casings, Bowl mills
II Steel Plants		Blast furnaces – sinter chutes, down comers, sinter fan chutes, bunkers for sinter return, hopper & drum feeder. Coke ovens-chutes, wharffs, Rotary Kilns – Kiln charging pipe, chutes.
III Coal Washeries		Slurry pipe lines, chutes, funnel and launders, cyclone hopper, coal washing pumps, delivery line, pump casing.
IV Cement Plants		Chutes, air separators, clinker exhaust fans, cement & raw mills.
V Chemical Plants		In the form of various pieces of equipment.

Major Benefits:

- Energy Saving & Environment Protection
- Extended Service Life for Ind. Equipment
- Wide Scope of Non- Ind. Application (Pavement Block, Canal Lining, Road in rural area)



CSIR-CGCR

Service to the Nation

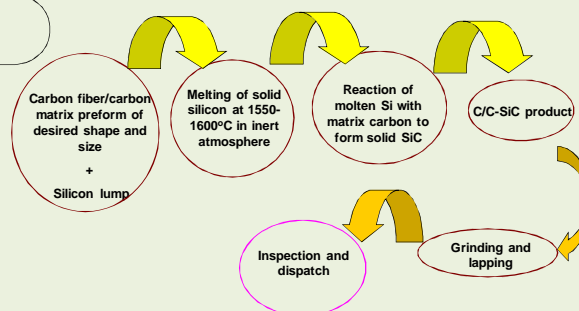
Value Additions



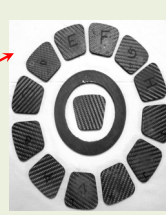
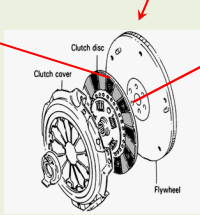
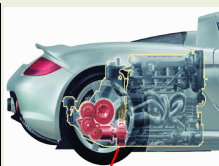
C/C-SiC clutch friction plates for automotive applications

Overview

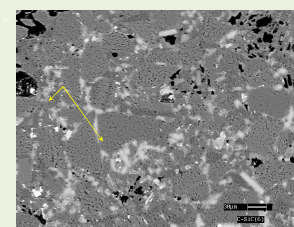
- Carbon fiber reinforced carbon-silicon carbide (C_f/C-SiC) composites are now-a-days used as brake material and clutch friction plate in high end automobiles, heavy duty trucks, high speed trains and aeroplanes.
- These ceramic matrix composite clutch plates are light weight, self-lubricated, highly wear resistant and have low friction coefficient that offer better performance and high product life than metallic clutch plates.



Property	C/C-SiC	Metal
Density (g/cc)	2.0-2.25	7.20
Strength (MPa)	150-220	1500
Stiffness (GPa)	375	200
Friction coefficient (μ)	0.2-0.4	0.4-0.7
Th. Cond. (W/mK)	120	40
CTE (10 ⁻⁶ /°C)	4.5	14.0
Max. temp. use (°C)	1600	600



Different parts of clutch plate assembly fabricated at NOCCD, CGCRI, Kolkata



Microstructure of milled carbon fiber SiC composite

Present status

Carbon fibre reinforced Silicon Carbide clutch friction plates are on the verge of acceptance for applications in the heavy vehicles. CGCRI has developed the technology for production of carbon fibre reinforced silicon carbide for other applications.

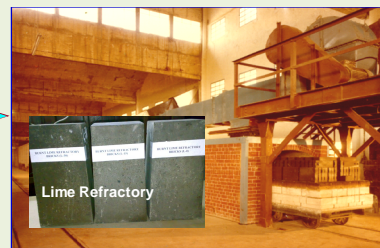
Lime Refractory for Secondary Steelmaking Developmental Stages

Advantage of Lime (CaO):

*High Melting Point (2600°C) * Highly Basic in Nature * Most stable oxide under vacuum



Laboratory development at CGCRI



Upscaling (10 Tons) at OCL India Ltd under MOU

Ready for Commercial Production

Field trial at a Steel Plant, Gujarat
Satisfactory performance

- Once commercialized, it will gradually replace dolomite refractory Globally
- Sintered lime is patented by CSIR/CGCRI. Patent on lime refractory is under process.
- CGCRI is jointly developing this refractory with OCL India Ltd.

CSIR-CGCRI

Service to the Nation



High Density – High Strength –Isotropic Graphite



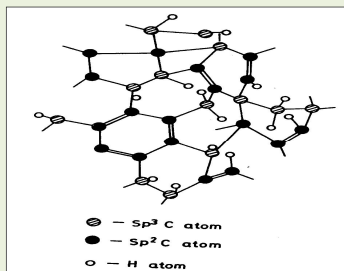
Utility / Advantages

- Electrodes of electric discharge machines (EDM)
- Heaters, Crucibles
- Seals & bearings
- Nuclear graphite,
- Rocket nozzles
- Moulds for continuous casting of metal and alloys etc

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DLC Coating



Density ($gm \cdot cm^{-3}$)	: 1.4 – 2.0
Hardness (GPa)	: 10 – 30
Modulus of Elasticity (GPa)	: 100-350
Refractive Index	: 1.8 - 2.2
Optical Gap (eV)	: 1.0 - 3.0
Resistivity ($\Omega \cdot cm$)	: 10^{10} - 10^{13}
Dielectric Constant	: 2.5 - 9.0

Application / Uses

DLC coating on inner surface of plastic bottles using an improved process and device has potential application in the entire food and drug industries.

DLC films on inner surfaces of plastic bottles will act as protective and barrier coating.

Applications includes; Container for beverage products like Beer, Fruit juice Carbonated soft drinks etc. and medicine & drugs.

Carbon Composite Rings

Carbon composites rings are light weight, transparent to X-ray and have better elastic deformation behavior compared to stainless steel rings.

A device used in the treatment of polio and other orthopedic deformities



Ceramic Coating for Photocatalysis & Self Cleaning Glass

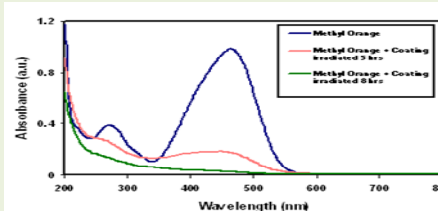
Advantages

- Preparation process involves a few simple steps and low cost equipment.
- Coating preparation requires low firing temperature.
- Exhibits photocatalytic activity and can decompose organic pollutants under UV-Visible light irradiation.
- Self-cleaning action of the coating demonstrates its potential to remove dirt build-up on roofs, facades, and windows.
- Excellent transmittance in the visible region and appreciably high electrochemical activity of the coating shows its utility as a passive counter electrode in electrochromic devices.

Applications

- As a photocatalyst for decomposing organic pollutants viz., Methyl, Methylene Blue, Eosin (Yellow), Violet, and Phenol Red under UV-Visible light irradiation.
- As a self cleaning glass for removing dirt build-up on roofs, facades, and windows.
- As a passive counter electrode in electrochromic devices.

Absorption Spectra of Methyl Orange Aqueous Solution



Specifications	
Property	
Cobr	Faint Yellow
Average Particle Size	16 nm
Band Gap	3.25 eV
Contact Angle	94°
Transmittance	> 80 %
Ion storage Capacity	20.5 mCcm ⁻²



CSIR-NPL

Service to the Nation

Paints and Coatings for Corrosion Protection

Conducting polymer based pigments



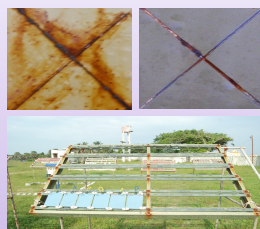
- Pigments based on conjugated or conducting polymers have been prepared
- Properties have been tailored to cater the specific application
- Pilot scale production of pigments has been demonstrated, using economically feasible raw materials

Formulation of pigment based paints



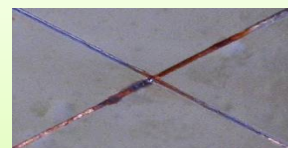
- Pigments have been loaded in suitable medium to form anticorrosive paints.
- Different formulations were prepared depending on the loading level of pigments, nature of pigment/medium.
- Paint formulations have been tested by various techniques as per specified ASTM standards.

Laboratory and Field Testing



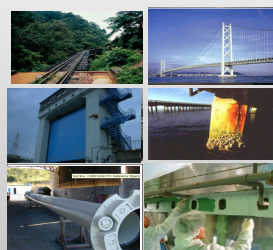
Panels have been tested by salt spray test under conditions to emulate sea environment

Salient features of paints/coatings



- Smart action and Self healing ability: pin hole/scratch site passivation.
- Environmental friendly/based on green technology (free from heavy metal ions and hazardous chromates).
- Long service life, economic feasibility and additional antistatic property.

Areas of application



Railway bridges, sea-link bridges, ship hulls, undersea oil pipelines, floodgates etc.

Industrial Participation



EIS test cell in progress

- Sharing a healthy relationship with industries like Krishna Conchem Products Pvt. Ltd, Mumbai, ACS-Chemical Innovations, Reliance, Asian Paints and Tata steel etc.
- Talks have been initiated with cement industries like Ultratech Cement and Aditya Birla Group for the water soluble conducting polymer based antirust (JangRodhak) cement.

Gas sensors and LPG Leak Detector

Specifications (LPG Gas detector)

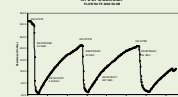
- Sensor material : Composite material
- Kovar lead, steel cap design
- Response time 80 seconds : Recovery time 400 seconds
- Power dissipation 2.5 watts : Operating voltage 5V
- Size 5mmX5mm : Package size 30mm (length) X 17mm (dia)
- Heater resistance ~6-8 ohms : Operating ~12 ohms
- Sensor resistance ~ 50 K Ohm : 2 K Ohm (1000ppm)

Processes

- Screen printing : heater/ electrodes
- Brush painting : sensor layer
- welding using parallel gap welder : leads



LPG sensors



Response curve



Gas testing facility



Parallel gap welder

Carbon-Ceramic Composites

CSIR-NPL

A special class of carbon based materials which overcome the main drawback of carbon, i.e. its oxidation in air at 800-1200°C, while essentially retaining its outstanding properties.

Utility / Advantages

- Heaters, Crucibles
- Seals & bearings
- Rocket nozzles
- hot-pressing dies
- automobile Pistons
- Engine Blades
- Moulds for continuous casting of metal and alloys.

Specifications

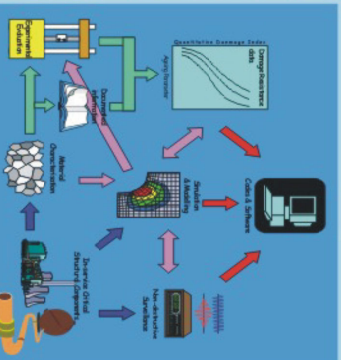
Bulk density	1.8 – 2.0 gcm ⁻³
Bending strength	90-130 Kgcm ⁻²
Compres. strength	1500 - 2000 kgcm ⁻²
Electrical resistivity	6-12 mohm cm
Shore hardness	70 – 80
Wt. Loss in air at (800-1200)	Negligible



SEM photograph of a carbon-ceramic composite showing a protective layer at the surface

Engineering Structures Assessment and Management

Modern-day industrial practices push critical engineering structures and components to the limits of their capacities. NML has developed tools and expertise to assess the integrity status of critical engineering structures. Networking with other - CSIR laboratories, it provides services for integrity evaluation and life management.



Over the years a variety of testing and characterization facilities have been built up to aid in the procurement of data in the laboratory and at site.

- On-going activities:**
- Generation of database on damage resistance of engineering materials
 - Understanding sub-structural mechanisms and surface processes of ageing and degradation
 - Development of signal and image processing techniques for damage assessment
 - Development of sensor devices for surveillance
 - Modelling and simulation of damage evolution
 - Development of software tools for life assessment and integrity management
 - Testing of full-scaled structures



Servo-hydraulic equipment



In-situ hysteresis & Magnetic Barkhausen Emission system

Contract research is undertaken on Failure Analysis, Remaining Life Assessment, Damage Assessment, Rejuvenation and Life Extension of critical structures and components. Work has been carried out for petro-chemical, thermal power, nuclear power, aerospace industries.



Impact Echo



Infra Red Technology



Power plant RLA



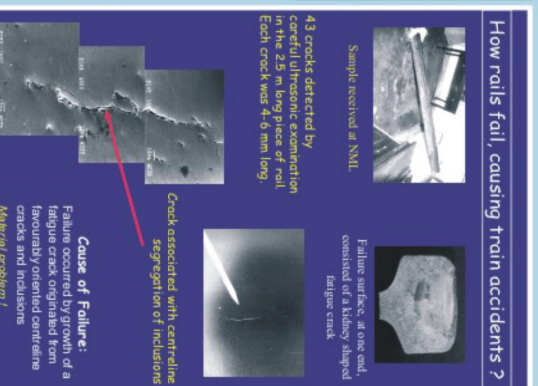
Measurement of blast furnace lining thickness by impact echo and LFUT



Assessment of Rolling Mill Works Rolls



Acoustic emission monitoring of Horton sphere



How rails fail, causing train accidents ?



Sample received at NML

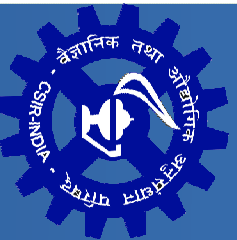


Failure surface, at one end, consisted of a blissy shaped fatigue crack



Crack associated with centrifuge segregation of inclusions

Cause of Failure:
Failure occurred by growth of a fatigue crack originated from favourably oriented centreline cracks and inclusions
Material problem!



Service to the Nation

CSIR-NML

CERTIFIED REFERENCE MATERIALS (CRM)

- Acknowledged as nodal agency for preparing metallurgical standards by the National Metrological Institution (NMI) of the country
- Currently marketing 24 metallurgical CRMs
- Client base above 300 customers across the world
- Enjoys more than 90% market share among Indian suppliers
- Development of Spectro-standards of Plain Carbon, Low and high alloy steels, Cast Irons are in progress



CRM finds applications in

- Validation of analytical results
- Validation of developed analytical protocols
- Checking human capabilities
- Calibrating analytical instruments

Main Users

- Primary & secondary steel manufacturers
- Foundries
- Universities
- R&D organisations
- Analytical laboratories

Unique Analytical Facilities

- Well organised conventional laboratory
- Total sample preparation facility
- State of art infra structure under a single window service
- Well experienced human resource
- A large inventory of primary reference materials
- Well established Quality Management System
- Close networking with other reputed analytical labs of the country



Analytical Expertise

- Handle the entire gamut of metallurgical samples
- Geo-chemical samples like ores and minerals
- Well established coal analysis laboratory
- Environmental samples like water and soils
- Rare Earth element analysis
- Gold quality assessment by ICP-OES technique

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