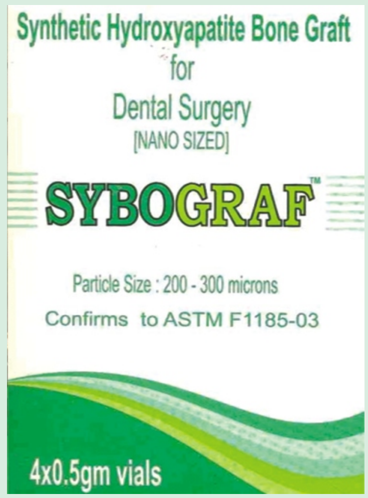
NML TECHNOLOGY HAND BOOK



NATIONAL METALLURGICAL LABORATORY

(Council of Scientific & Industrial Research)

JAMSHEDPUR, INDIA

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

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

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

NML
Technology Handbook

National Metallurgical Laboratory

Coluncil of Scientific and Industrial Research

JAMSHEDPUR, INDIA

2010

NML Technology Hand Book

(Revised Edition)

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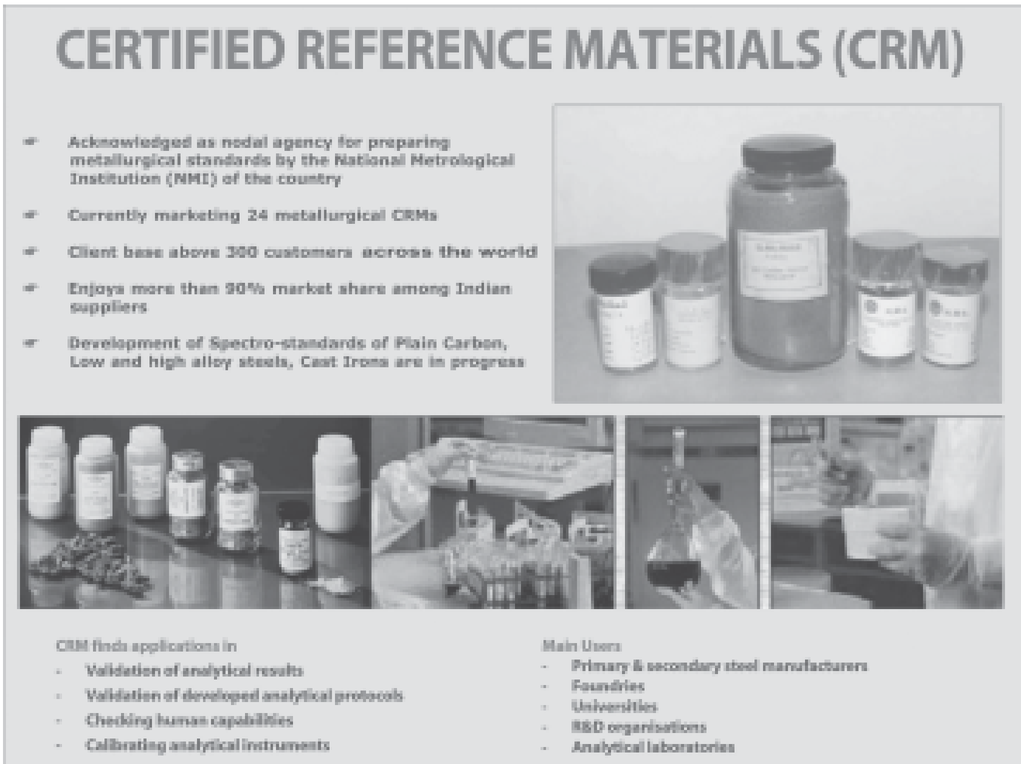

CERTIFIED REFERENCE MATERIALS (CRM)
Acknowledged as nodal agency for preparing metallurgical standards by the National Metrological Institution (NMI) of the country
Currently marketing 24 metallurgical CRMs
Client base above 300 customers across the world
Enjoys more than 90% market share among Indian 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

Process	Standard Reference Materials
Area	Chemicals
Uses	Standardization of analytical methods, calibration of analytical instruments
Salient Features	These Standard Reference Materials have been analysed by several renowned Institutions/ Laboratories for the correctness of the values reported
Scale of Development	100 kg batch
Major Raw Materials	As per requirement of the sample
Major Plant Equipment/ Machinery	Crushers, grinders, lathes, modern analytical equipments
Details of specific application	To standardize analytical methods and calibrate analytical instruments
Status of Development	100 kg batch
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Nil
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Certified Reference Materials, SRM, Standard Reference Materials

Process	A process for iron and arsenic removal from groundwater using naturally occurring minerals
Area	Water Purification, Arsenic Removal
Uses	Treatment of arsenic contaminated groundwater and make it suitable for the purpose of drinking
Salient Features	A naturally occurring ferruginous manganese ore (FMO) has been used for the removal of iron and arsenic from contaminated groundwater. The process may be applied in both domestic as well as community level water treatment units. A domestic three compartment filtration unit has been developed at NML using this process. Arsenic and iron removal efficiency and the time needed for that may be improved by the addition of appropriate flocculants At domestic level the process does not require electricity. FMO acts as an adsorbent of iron and arsenic. It works for both As (III) and As (V) without any pre-treatment. All consumables including FMO are low cost and environment friendly. The process comes with a sludge management protocol.
Scale of Development	The process is standardised at bench scale
Major Raw Materials	Ferruginous manganese ore
Major Plant Equipment/ Machinery	It is a three container water filter with very small capital investment
Details of specific application	The process is used for water purification and Arsenic removal from ground water
Status of Development	The filter unit has been developed and field tested. It is ready for commercialisation
Ecological/Environmental Impact (if any, specify briefly)	This is expected to address the groundwater arsenic contamination at domestic level and will provide the user safe drinking water at an affordable cost. The process is environment friendly. All consumables used in the process including FMO are nontoxic. The process comes with a sludge management protocol.
Patenting details	Patent Filed
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Arsenic, Groundwater Treatment, Naturally Occurring Minerals

Process	A process for electroless nickel plating from acidic baths at room temperature
Area	Corrosion and Protection
Uses	Plating electronic, industrial automobile and aerospace components
Salient Features	The process is simple, low capital intensive and can easily be adopted in a small scale sector. The nickel plating is done from the prepared and filtered solution using low AC potential. The process is very economical since plating is done at room temperature compared to 80-100^{o}C in the conventional processes. The control is also much better and gives superior coating with low porosity and high corrosion resistance.
Scale of Development	Bench Scale
Major Raw Materials	Nickel salts, sodium hypophosphite, chemicals for complexing and stabilisers, acids/alkalies
Major Plant Equipment/ Machinery	AC transformer, tanks for degreasing, pickling and plating, filtration unit, cables/jigs
Details of specific application	Finds major application for plating electronic, industrial automobile and aerospace components when high corrosion resistance, hardness and other special properties are desired.
Status of Development	Process is standardised at scale of 5 litres bath (150 x 100 mm panels were plated)
Ecological/Environmental Impact (if any, specify briefly)	Effluent generated during the process needed to be treated before disposing
Patenting details	Patent Application No. 1278/DEL/90, Dated 18.12.90
Commercialisation Status	Ready for Commercialisation
Techno-Economics	Available on demand
Key words	Nickel Plating, Corrosion Resistance

Process	Ethyl Silicate Based Zinc Rich Primer
Area	Corrosion and Protection
Uses	Used for the protection of storage tanks, offshore structures, under carriage of automobiles, railway wagons etc.
Salient Features	A unique process to make self cured zinc silicate primer based on partially hydrolysed ethylsilicate-40. The primer gets cured within 2 to 3 hours and offers cathodic protection to the structures. The top coat is compatible with the primers
Scale of Development	The process is standardised at a scale of 10 litres/day
Major Raw Materials	Zinc powder, ethylsilicate-40, ethylene glycol-monoethyl ether and other chemicals
Major Plant Equipment/ Machinery	High speed mechanical stirrer, strainers to remove any oversize materials and distillation unit
Details of specific application	Used for the protection of storage tanks and offshore structures
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	NA
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Zinc silicate, Zinc rich primer

Process	A flux to reduce dross and ash generation during hot dip galvanising of steel components and increase zinc utilization factor
Area	Corrosion and Protection
Uses	Hot dip galvanizing of steel structures, sheets, pipes, nuts, bolts and similar other articles made of mild steel or low alloy steels
Salient Features	The flux is developed in such a way that it forms a fusible stable composition on articles to be galvanized thus inhibiting the reaction of molten zinc with the steel surface. A controlled reaction of molten zinc with steel helps in reducing the byproduct generations. This controlled reaction also helps in the development of zinc/iron alloy layer at the coating interface with improved microstructure thus resulting in an enhanced resistance to corrosion. The effective surface active agent added in the flux reduces the surface tension of solution of flux and helps in uniform spreading of the flux over entire article to be galvanized
Scale of Development	The process has been developed on bench scale
Major Raw Materials	Zinc chloride, ammonium chloride, sodium tetra borate deca hydrate, hydrochloric acid
Major Plant Equipment/ Machinery	NA
Details of specific application	Hot dip galvanizing of steel structures, sheets, pipes, nuts and bolts
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	Environment friendly
Patenting details	Patent Application No.: 0181/DEL/2009, Dated 31.03.2009
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Keyword	Hot dip galvanising, Zinc utilization factor

Process	Metasave
Area	Corrosion and Protection, Chemicals
Uses	Pickling of steel in sulphuric acid, hydrochloric acid & phosphoric acid
Salient Features	A unique inhibitor having high molecular weight, multi structural bonds and presence of localised electron density at active centres enables the product to be very superior in application with proven inhibition efficiency of over 90% at all operating concentrations of acids and temperatures. It enables to reduce acid consumption by 30%, metal dissolution by 50% dumped acid concentration by 50% and fume generation by 80 to 90%
Scale of Development	Process standardised at bench scale
Major Raw Materials	Polymers of high molecular weight, amine and thio-compounds
Major Plant Equipment/ Machinery	Tanks, stirrers, filtration assembly, vacuum pumps, weighing machine
Details of specific application	Pickling of steel in sulphuric acid, hydrochloric acid & phosphoric acid
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Patent Filed
Commercialisation Status	Process licensed to few industries and is in commercial production. Product is being used by several steel plants
Techno-Economics	Available on demand
Key words	Inhibitor, Corrosion and Protection, Metasave

Process	NML-Galvaflux
Area	Corrosion and Protection, Chemicals
Uses	Pre fluxing in dry galvanizing of iron and steels
Salient Features	A considerable amount of zinc is wasted as dross during the galvanizing of iron and iron based alloys. Pollution problems are also encountered due to the use of $ZnCl_2/NH_4Cl$.To avoid these problems, a flux based on triple salt is invented Three steps of chemical synthesis is required to get the desired products. 20-30% aqueous solution of flux is prepared and the fluxing of articles to be galvanized is performed for 30-60 seconds at room or slightly elevated temperature
Scale of Development	Standardized at 1000 kg per day scale
Major Raw Materials	$ZNCl_2$, NH_4Cl, other chlorides, surfactants
Major PlantEquipment/ Machinery	Reaction vessel, boiler, filter press, centrifuge
Details of specific application	Galvanization of iron and steels
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Patent Filed
Commercialisation Status	Transferred to few industries
Techno-Economics	Available on demand
Key words	Prefluxing, Galvanizing, Galvaflux, Inhibitor, Corrosion and Protection

Process	NML-Galvasave
Area	Corrosion and Protection, Chemicals
Uses	Passivation of galvanized tubes and sheets to prevent white rust
Salient Features	The process is simple, low capital intensive and can easily be adopted in small/large scale sectors. In the process, the ingredients are dissolved in hot (85±5^{O}C) water with high speed stirrer and cooled. Activators and passivators are prepared under controlled conditions and mixed with other ingredients. The process is simple and does not require big plant and machineries
Scale of Development	The process standardized at a scale of 3000 litre per week
Major Raw Materials	Water borne polymers, chromium based compounds, Acids (Inorganic/organic)/surfactants/oxidizers
Major Plant Equipment/Machinery	HDPE Tank, High speed stirrer, Immersion heater
Details of specific application	Passivation of galvanized tubes and sheets
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Patent Filed
Commercialisation Status	Transferred to few Industries
Techno-Economics	Available on demand
Key words	Passivation, Galvanization, Corrosion and Protection, Galvasave

Process	NML-HCl Inhibitor
Area	Corrosion and Protection
Uses	Used for pickling of steels in hydrochloric acid at room temperature to 70^{o}C, cleaning of boilers, tubes, auto-radiators, cleaning of choked steel pipes, heat exchanger tubes, etc.
Salient Features	A unique acid inhibitor inhibits hydrogen absorption by steels adequately. Based on polymer compounds with proven efficiency of 97% in 15% HCl. It enables to reduce acid consumption by 60%, metal dissolution by 55%, and acid mist by 95%
Scale of Development	The process standardized at a scale of 50 litre/day
Major Raw Materials	Amines/heterocyclic compounds
Major Plant Equipment/Machinery	Reflux system with reaction cell, Heater, Stirrer
Details of specific application	Pickling of steels, cleaning of boilers, tubes and auto-radiators
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Patent Filed
Commercialisation Status	Process licensed to few industries and is in commercial production
Techno-Economics	Available on demand
Key words	Inhibitor, Corrosion and Protection

Process	A process for the reclamation of coal mine water
Area	Water Purification, Mine Water Reclamation
Uses	Provision of safe drinking water from polluted coal mine water
Salient Features	Coal mine ground water normally contains three major classes of contaminants, viz., suspended particulate matter, dissolved solids and microorganisms. Suspended particulate matters comprise coal fines, clay matter and other types of floating solid particles, dissolved solids comprise, iron, calcium, magnesium, heavy metal ions and non-ionic contaminants such as fluoride, chloride, nitrate, sulphate etc. and colliform group of bacteria are the major contributors to the microorganism category. Coal mine water reclamation process developed at NML addresses sequentially all three categories in a modular manner. Suspended particulate matters are separated using appropriate flocculants. Toxic dissolved matters such as heavy metal ions are removed using a nanometric aqueous suspension. Harmful microorganisms are addressed through ozonation. The final product is envisaged to be reclaimed coal mine water suitable for the purpose of drinking
Scale of Development	25000 LPD
Major Raw Materials	Underground coal mine water
Major Plant Equipment/Machinery	Flocculation tank, reaction tank, clarifier, filter, ozonator
Details of specific application	In water purification and mine water reclamation
Status of Development	Prototype of the plant has been installed and commissioned at NML. The work on 25000 LPD unit is in progress in Dhanbad
Ecological/Environmental Impact (if any, specify briefly)	This is expected to alleviate the local drinking water problem to a large extent. This will also reduce the load on adjacent river and other surface water bodies. Wanton disposal of coal mine groundwater has an indelible effect on the ecosystem of the area. On one hand this lowers the water table causing acute water crisis and on the other hand disposal of polluted water into freshwater bodies disturb the flora and fauna of the water bodies. The process developed at NML will be beneficial for the environment from both the angles
Patenting details	Patent Filed
Commercialisation Status	On successful implementation of the 25000 LPD plant at BCCL premise, they will further put similar plants in other collieries
Techno-Economics	Available on demand
Key words	Water treatment plant, Coal Mine Water, Safe Drinking Water

Process	Rust Stabiliser
Area	Corrosion and Protection
Uses	Converting rusted surface into a base for paint application
Salient Features	The raw materials such as phosphoric acid, alcohols, dichromate and certain other additives are mixed in proper proportion and agitated thoroughly at room temperature. A homogenous solution so obtained is applied on the rusted surface and kept for 2-3 hours for complete reaction and drying. The surface is ready for application of organic based paints/primers.
Scale of Development	The process is standardised at bench scale.
Major Raw Materials	Sodium dichromate, phosphoric acid, resin and methanol.
Major Plant Equipment/Machinery	Reaction Vessels, Weighing Machine
Details of specific Application	Converting rusted surface into a base for paint application
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Nil
Commercialisation Status	The process has been licensed to few industries
Techno-Economics	Available on demand
Key words	Rust Stabiliser, Corrosion and Protection

Process	Preparation of zinc powder based coating to control uniform and pitting corrosion of reinforcement bars in concrete environment
Area	Corrosion and Protection
Uses	To protect against corrosion of the steel reinforcement bars exposed in chloride contaminated concrete pore solution
Salient Features	A zinc powder based coating has been developed incorporating transition metals oxides as pigment in the formulation of zinc based coating where the metals oxide pigments act as percolent in the coating, increase the conductivity of the coating, promote the formation of passive film on zinc surface and increase the life of coating finally results in a protective system to control corrosion of steels in contact of concrete environments. This will protect steel rebars having improved corrosion resistance in concrete pore solution, which comprises the protective zinc based coating incorporating pigments, which helps in the formation of a passive layer on a zinc surface & thus, ennobling the corrosion potential above the hydrogen evolution potential, thereby reducing the pitting resistance and enhance the life of coating making it cost effective
Scale of Development	The process has been developed on bench scale
Major Raw Materials	Zinc powder , xylene, ethoxy ethanol, butoxy ethanol, ethoxy butanol, manganese dioxide, organic polymeric binder
Major Plant Equipment/ Machinery	Analytical equipments
Details of specific application	To protect against corrosion the steel reinforcement bars
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	Environment friendly
Patenting details	Patent Application No. 0177/DEL/2009, Dated 30.01.2009
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Keyword	Zinc Powder, Coating, Pitting Corrosion

Process	High purity copper powder from copper wastes scrap by direct electrolysis
Area	Waste Recycling
Uses	For manufacturing the bearings, aerospace materials, electrical contacts etc.
Salient Features	Obtained copper powder from copper containing industrial wastes employing direct electrolysis. The process uses anode support system made of stainless steel in an electrochemical cell. The process is useful for producing copper powder directly utilizing the industrial copper wire scrap housed in the anode support system in place of conventional copper plates made from smelting of industrial copper wire scrap. Copper sulphate solution with sulphuric acid is used as electrolyte
Scale of Development	Process standardized at a scale of 150 g batch
Major Raw Materials	Copper wastes scrap
Major Plant Equipment/Machinery	Rectifier, electrolysis tank, sieves of different mesh
Details of specific application	Producing high purity copper powder ~ 99%
Status of Development	The process could be demonstrated on ½ kg scale
Ecological/Environmental Impact (if any, specify briefly)	No harmful environmental impact
Patenting details	Patent Application No : 0180/DEL/2009, Dated 30.09.2009
Commercialisation Status	Ready for commercialisation
Techno-Economics	Can be made available on demand
Key words	Copper Wastes Scrap, Copper Powder, Direct Electrolysis, Anode-support System

Process	Fluxed sinter through micro-pelletization utilizing waste Iron oxides fines
Area	Ferrous Process
Uses	Steel making as suitable flux
Salient Features	The process produces a sinter using 100% ultra-fine waste oxide material generated in steel plant viz. LD sludge, BF flue dust and lime fines (10 to 55%) through micro-pelletization for their recycling. Sintering is possible neither using any external heat nor any coke breeze and the waste material itself is the heat source. The produced sinter is suitable for using in both iron and steel making processes.
Scale of Development	10 kg / batch
Major Raw Materials	LD Sludge, BF-Blue Dust and Lime Fines
Major Plant Equipment/Machinery	Pelletizer, Sinter Plant
Details of specific application	Steel making process
Status of Development	Feasibility is tested in the Laboratory scale
Ecological/Environmental Impact (if any, specify briefly)	No harmful/hazardous effect on environment
Patenting details	Patent Application No. 2375/DEL/2009, Dated 18.11.2009
Commercialisation Status	Ready for commercialisation
Techno-Economics	Can be made available on demand
Key words	LD sludge, BF flue dust, lime fines, micro-pelletization, sintering, utilization of waste oxides

Process	Geo-polymer cement from fly ash and granulated blast furnace slag
Area	Cement
Uses	The geopolymer cement is used as binder material, main ingredient in precast concrete blocks, fire resistant and insulated panels, decorative stone artefacts, building materials, cast ceramic tiles, and immobilization of toxic wastes.
Salient Features	The process gains the very high compressive strength in short time (20-60 MPa in 4 hours and 30-120 MPa in 24 hours). The geopolymer cement uses two major industrial waste, fly ash and granulated blast furnace slag, as the major raw material (up to 95% of total composition
Scale of Development	Laboratory Scale
Major Raw Materials	Blast furnace slag, sodium or potassium based alkaline activator
Major Plant Equipment/ Machinery	Comminution equipment
Details of specific application	For production of geo-polymer cement
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Patent No: KR 10-0857616, AU 2007200162
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Geo-polymer Cement, Fly Ash, Mechanical Activation, Blast Furnace Slag

Process	Geopolymer paving blocks/ tiles from fly ash, BF slag and other industrial waste
Area	Waste Utilisation
Uses	The process produces self-glazed geopolymer tile/block of different shapes and sizes and different colours and designs. These self-glazed tiles shall be useful as decorative wall tiles for building and construction industry.
Salient Features	In this process the glazed surface occurs on the geopolymer tile automatically and without any secondary processing. Geopolymer tiles/blocks uses two major industrial waste, fly ash and granulated blast furnace slag, as the major raw material (up to 95% of total composition)
Scale of Development	In bench scale
Major Raw Materials	Granulated Blast Furnace Slag, Fly Ash, Alkaline Activators, Super Plastisizer
Major Plant Equipment/ Machinery	Weighting machine, milling devices, granulator, Mixer, hydraulic press
Details of specific application	In building and construction industries
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Patent Application No. AU 2007200392
Commercialisation Status	Ready for commercialization
Techno-Economics	Available on demand
Key words	Geopolymer, Paving Blocks, Tiles, Fly Ash, BF Slag, Industrial Waste

Process	Iron oxide from waste iron rich sources
Area	Waste Utilisation
Uses	Hematite has variety of application as photosensitive material, catalyst, high quality pigments, and cosmetics besides its major use as magnetic materials mainly for producing both soft and hard ferrites
Salient Features	High purity mono dispersed hematite particles of very uniform sizes and shapes have been produced by low temperature aqueous synthesis route in large quantities with a yield of almost 100% starting from very inexpensive and impure iron sources such as blue dust, scraps, pickle liquors, crude iron oxide, high iron containing residues etc. Low temperature aqueous synthesis method produce very uniform size and shapes of iron oxide from very inexpensive and impure iron sources. The mono dispersed hematite particles of different shapes such as cubic, spindle, ellipsoidal, spherical, peanut type particle can be produced by this method. Different shapes of uniform size mono dispersed hematite particles of size ranging from 200 - 2000 nm can be produced
Scale of Development	250 gm Scale
Major Raw Materials	Waste Chloride Pickle liquor, Blue dust, Scrap iron, High Iron containing waste
Major Plant Equipment/ Machinery	Precipitation Reactor, Filter Press
Details of specific application	Ultra-pure mono dispersed ferric oxide Fe_2O_3 - 99.6 (min), SiO_2 - 0.005% (max), CaO - 0.05% (max), Al_2O_3 - 0.005% (max), Cl - 0.05% (max), SO_4 - 0.005% (max)
Status of Development	The process is tested for production of 250 g iron oxide
Ecological/Environmental Impact (if any, specify briefly)	The process uses a low temperature synthesis method and involves minimum unit operation. The liquid effluent generated is nontoxic and can be suitably treated for disposal
Patenting details	Patent Filled
Commercialisation Status	Ready for Commercialisation
Techno-Economics	Available on demand
Key words	Iron Oxide, Hematite, Pickle Liquor, Blue Dust

Process	Lead recovery from lead containing residues
Area	Hydrometallurgy
Uses	Recovery of lead
Salient Features	A simple process flow-sheet comprising of washing, brine leaching and cementation of lead is developed for recovery of lead from zinc plant residue containing about 10% lead along with other impurities. The process requires low cost leadchants which are recycled in the system after lead recovery. The process can take care of raw material containing lead in wide range. Process gives very high recovery of lead.
Scale of Development	1 kg Scale
Major Raw Materials	Lead containing residue
Major Plant Equipment/ Machinery	Leaching Reactors, Fibre Process
Details of specific application	Recovery : Pb - 72 - 80% and Fe - 20 - 28%
Status of Development	The complete flow-sheet is developed for recovery of lead as cement lead on 1 kg scale with overall recovery of 95% lead. The process demonstrated and know-how is transferred.
Ecological/Environmental Impact (if any, specify briefly)	The process is a zero waste technology and no liquid effluent is generated in the process. The solid leached residue containing very about 0.1% lead is generated which can be converted to various other useful products.
Patenting details	Patent Filed
Commercialisation Status	Transfered to few industries
Techno-Economics	Available on demand
Key words	Lead, Zinc Plant Residue

Process	Lithium Chemicals
Area	Chemicals
Uses	Applications in ceramics, steel, as fluxing agent, glass lining of water heaters, glass, Production of other lithium chemicals including lithium metal
Salient Features	The process involves roasting of ground ore (lepidolite - 2.5 to 4 % Li_2O) with alkali sulphate followed by water leaching and subsequently treating with carbonate salt. The recovery of lithium and purity of lithium carbonate from this process was obtained as 90-92% and 98% respectively
Scale of Development	2 kg/day Lithium carbonate
Major Raw Materials	Lepidolite, Alkali Sulphate, Carbonate Salts, Water
Major Plant Equipment/ Machinery	High temperature continuous furnace, constant stirred tank reactor, solid-liquid separation unit.
Details of specific application	Applications in ceramics, steel, as fluxing agent, glass lining of water heaters, glass and production of other lithium chemicals
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Patent Number: IN 225749, Dated 27.11.2008
Commercialisation Status	Transferred to industries
Techno-Economics	Available on demand
Key words	Lithium, Chemicals

Process	Mag Chem
Area	Chemicals
Uses	Magsulph can be used for manufacturing high quality magnesite bricks, fire proofing, micronutrients for tea gardens, pharmaceuticals etc. and as a starting material for other Mag-chemicals
Salient Features	Magnesite duct containing 40-50% MgO (60-80 mesh) is treated with sulphuric acid under controlled conditions and is followed by crystallization. After solid-liquid separation, mag-sulph crystals are produced which can be utilized for producing magnesium carbonate with sodium sulphate as a by-product
Scale of Development	The process was developed at Laboratory cale of 5 kg/day
Major Raw Materials	Magnesite Dust, Sulphuric Acid, Water
Major Plant Equipment/ Machinery	Constant Stirred Tank Reactor, Crystallizer Centrifuge, Fitter Press, Small Boiler
Details of specific application	Used for manufacturing high quality magnesite bricks, fire proofing, micronutrients for tea gardens, pharmaceuticals etc.
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Patent No.: IN195823, Dated 21.04.2006
Commercialisation Status	Transferred to industries
Techno-Economics	Available on demand
Key words	Mag-sulph, Chemicals

Process	Nickel From Spent Nickel Catalyst as Ferro-nickel
Area	Pyro metallurgy
Uses	Nickel is used as alloying element in making of alloy steel
Salient Features	The simple smelting process is developed for recovery of nickel as ferronickel of various grades from different nickel catalysts containing nickel in the range, 8 - 18%. By controlling the parameters and the process techniques, ferronickel of 20 - 75% Ni grade have been produced with above 90% recovery. The process consists of mixing the spent catalyst with additives, heating and reducing the mixture to get ferro-nickel. The process recovers above 90% of Ni.
Scale of Development	5 kg./ batch of the spent catalyst
Major Raw Materials	Spent nickel catalyst, mill scale (iron oxide), reducing agents
Major Plant Equipment/ Machinery	Oil/gas fired furnace, reaction vessels
Details of specific application	Recovery: Ni = 25-75 %,Fe =20-70%, Si =0.1-4 %
Status of Development	10 kg Scale
Ecological/Environmental Impact (if any, specify briefly)	The slag generated is non-toxic and can be dumped
Patenting details	Patent Filed
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key Word	Nickel, Spent Nickel Catalyst, Ferronickel

Process	Nickel Sulphate from Spent Nickel Catalyst
Area	Hydrometallurgy
Details of Collaborating	Catalyst user industry
Uses	Nickel sulphate is extensively used in electroplating, organic chemical synthesis, metal colouring, dye mordant, manufacturing other nickel salts, Ni-Cd battery
Salient Features	Nickel catalysts used in various operations become spent after several cycle of use, for which a very simple and innovative process is developed at NML for recovery of nickel. The processing step consists of direct acid leaching in presence of a promoter followed by impurity removal to produce nickel salt/metal. The novelty of the process is that, it gives very high nickel recovery (99%) under the moderate conditions in presence of a little quantity of a promoter without which it is found to be very poor even at higher temperature and acid concentration. The process requires only little excess to the stoichiometric amount of acid for almost complete dissolution of nickel at moderate leaching temperature. It requires less amount of alkali in the purification step and generates less amount of sludge. The process gives very high recovery of nickel.
Scale of Development	1 kg Scale
Major Raw Materials	Spent nickel catalyst, Sulphuric acid
Major Plant Equipment/ Machinery	Leaching reactors, Filter press, Crystallizer, Centrifuge
Details of specific application	Ni - 22.2% (min), Co - 0.002% (max), Cu- 0.0006% (max), Fe - 0.001% (max), Pb - 0.0002% (max), Zn - 0.0002% (max), Ca- 0.005% (max), Mg - 0.004% (max), Insoluble - 0.005% (max).
Status of Development	The complete flow-sheet is developed to recover nickel as nickel sulphate on 1 kg scale with overall recovery of 96% nickel
Ecological/Environmental Impact (if any, specify briefly)	The process is a zero waste technology and no liquid effluent is generated in the process. The solid residue generated is either a marketable or can be converted to a useful product. Therefore the process is environmental friendly.
Patenting details	Patent Filed
Commercialisation Status	Technology transferred to few industries
Techno-Economics	Available on demand
Key Word	Nickel Sulphate, Spent Nickel Catalyst

Process	Production of Portland Pozzolana Cement involving simultaneous usage of raw and mechanically activated fly ash
Area	Cement
Uses	Buildings and construction industries, dams, roads, bridges, large scale structures
Salient Features	In this process mechanical activation allows to use the higher proportion (25-75%) in Portland pozzolana cement and gives the properties equivalent to the cement containing total mechanically activation fly ash. The products produced by the process have better early compressive strength (1 day 1-10 MPa, 3 day 10-20 MPa) that the products produced by conventional processes (1 day 1-5 MPa, 3 day 5-16 MPa)
Scale of Development	Bench Scale
Major Raw Materials	Fly Ash, Gypsum, Cement Clinker
Major Plant Equipment/ Machinery	Comminution set-up
Details of specific application	Used in buildings and construction industries
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Patent Application No: 0291/DEL/2008, Dated 01.02.2008
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Portland Pozzolana Cement, Mechanical Activation, Fly Ash

Process	Tungstic acid from hard and soft tungsten-copper (W-Cu) alloy scraps by hydrometallurgical Processes
Area	Waste Recycling, Hydrometallurgy
Uses	Recovery of tungsten as tungstic acid which can be used in die industry. The same tungstic acid could be used for the production of tungsten powder by hydrogen reduction
Salient Features	The process employing electrolysis, solvent extraction and precipitation processes. The electrolysis process uses to dissolve the hard W-Cu alloy scrap in alkaline solution with suitable additive. The process is useful for dissolving hard W-Cu alloy scrap housed in the anode support system. The copper dissolved in the electrolyte solution is separated by precipitation/solvent extraction process. The tungsten left behind in the electrolyte solution can be recovered as tungstic acid by the solvent extraction and/or precipitation process.
Scale of Development	For hard tungsten-copper alloy scrap: 1.5 kg/batch and for soft tungsten alloy scrap: 25 g/batch
Major Raw Materials	Hard tungsten-copper alloy scrap and soft tungsten-copper alloy scrap
Major Plant Equipment/ Machinery	Rectifier, Electrolysis Cell, Rotary Evaporator, Leaching Reactor
Details of specific application	Producing Tungstic acid: 99.80% tungsten
Status of Development	The process can be demonstrated on 1.5 kg scale
Ecological/Environmental Impact (if any, specify briefly)	No harmful environmental impact
Patenting details	Patent Application No. 0566/DEL/2009, Dated 24.03.2009 and 0564/DEL/2009, Dated 22.03.2009
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Tungsten-Copper, Tungstic Acid

Process	Wear Resistant Ceramics using Fly Ash
Area of Technology	Waste Utilisation
Uses	Fly Ash has been used as one of the major raw material to partially substitute the alumina. The Fly Ash consists mainly of silica and alumina. The alumina present in Fly Ash can be used as source and silica as bonding materials
Salient Features	The type of wear resistant ceramic products can be produced using 10, 25 and 40wt% fly ash for high, moderate and low wear resistant applications. The products are harder than tool steel and next to diamond on Moh's scale of hardness. These extremely hard, dense and impenetrable ceramics, which finds a number of industrial applications, substantially decrease the maintenance cost of equipment and increase the life of components 8-10 times to that of metal. There can be many successful application of the presently developed wear resistant ceramics in place of alloy sttel, basalt and high alumina liners
Scale of Development	Pilot scale
Major Raw Materials	Fly Ash, Technical Alumina, Alumino-silicate minerals, additives
Major Plant Equipment/Machinery	Weighing machine, Ball Mill, Filter press, Granulator, Mixture, Hydraulic Press, Kiln
Details of specific application	Areas which are prone to wear such as material handling equipment, pipe lines, chutes, bunkers, hoppers, ball mills, etc.
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	The present technology will help in reducing pollution control as it uses fly ash, which is waste material
Patenting details	Patent Application No. 1264/DEL/93 dated 11.11.1993
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Fly Ash, Alumina, Wear Resistant, Pollution Control, Ceramics

Process	Acid /Metallurgical Grade Fluorspar
Area	Mineral Beneficiation
Uses	Major applications in (a) fluorine Chemicals (b) Iron and steel industries
Salient Features	The process is based on forth flotation of the milled ROM with some chemical reagents, dewatering, drying and agglomeration of met. grade concentrate. The process can treat low grade ore producing, high grade concentrate suitable for application in metallurgical and chemical industries
Scale of Development	The process developed on a 20 tpd basis
Major Raw Materials	ROM ore, oleic acid, sodium silicate, katha and caustic soda
Major Plant Equipment/ Machinery	Primary and secondary crushers, grinding unit, conditioners, Flotation banks, Reagent feeders, pumps, Thickeners, Filter, Dryer Briquetting/ pelletizing units, bagging unit, water reclamation system
Details of specific application	The process is applicable to beneficiation of low grade fluorite ore with quartz as the major gauge.
Status of Development	Process was developed at 20 tpd scale and commercialised
Ecological/Environmental Impact (if any, specify briefly)	Arrangement for disposal of trailing and effluents are needed
Patenting details	Nil
Commercialisation Status	Transferred to few industries
Techno-Economics	Available on demand
Key words	Low Grade Fluorspar, Acid/Metallurgical Grade Concentrate, Froth Flotation

Process	Agglomeration of Iron Ore & Concentrates from Slimes
Area	Mineral Processing
Uses	Process development for setting up the commercial sinter plant as well as for the improvement in the existing sintering process so as to produce quality Sinter from Iron Ore Fines
Salient Features	The sinter properties are influenced greatly from the sinter chemistry which is fixed in view of the BF requirement. Besides, the requirement of coke in the Indian sinter plant is high and Productivity is low. A technology has been developed to improve the RDI and RI of super-fluxed sinter through improvement in sintering efficiency. The technology also encompasses lowering of fuel consumption and improvement in the productivity of sinter plant
Scale of Development	Pilot Scale (Implemented in the commercial plant)
Major Raw Materials	Iron Ore Fines, Fluxes (Limestone, Dolomite or Other Mg bearing minerals), Coke Breeze, Lime and Metallurgical Wastes
Major Plant Equipment/Machinery	Preparation and Mixing Circuits of major raw materials, Sinter Machines, Sinter Cooler
Details of specific application	IS 9963:1981 and IS 6495:1984 for the shatter and tumbler tests of sinter respectively. RDI and RI tests follow standard measuring practice in Tata Steel or elsewhere
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	The process is environment friendly. Besides the emission of green house gas and other harmful ones is lowered.
Patenting details	Nil
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Iron ore, Sinter, Cold strength, RDI and RI

Process	Heavy Minerals from Beach Sand
Area	Mineral Beneficiation
Uses	For manufacture of superior value-added products from ilmenite, garnet, zircon, sillimanite and manite
Salient Features	After careful study of the minerals and impurities present, selected physical separation steps are employed involving gravity, magnetic, high tension separation and flotation techniques. Depending upon the characteristics of the beach sand it produces high purity ilmenite, zircon, garnet, monazite and sillimanite concentrate for various industrial uses
Scale of Development	Beach and pilot plant scale, up to 1 tph
Major Raw Materials	Beach sand heavy minerals, Flotation reagents.
Major Plant Equipment/Machinery	Gravity, Magnetic, HT separation, Flotation cells, Grinding mills, Reagent feeders, conditioners, Dewatering units, conveyers, pumps
Details of specific application	The process is applicable for the recovery of heavy minerals from low grade beach sand
Status of Development	Pilot scale
Ecological/Environmental Impact (if any, specify briefly)	In case of recovery of sillimanite by froth flotation arrangement for disposal of tailings is to be made
Patenting details	Nil
Commercialisation Status	Ready for commercialization
Techno-Economics	Available on demand
Key words	Beach Sand, Heavy Minerals, Flotation, Separation Process

Process	Beneficiation of Low grade Iron Ores
Area	Mineral Processing
Uses	The technology developed is for beneficiating low grade iron ores. The calibrated lumps, fines & concentrate so produced are used for iron & steel making
Salient Features	The process so developed basically involves crushing, classification, processing of lumps, fines and slimes separately to produce concentrate suitable as lump and sinter fines and for pellet making. The quality is essentially defined as Fe contents, Level of SiO_2 and Al_2O_3 contamination. The process aims at maximizing Fe recovery by subjecting the rejects/tailings generated from coarser size processing to fine size reduction and subsequent processing to recover iron values
Scale of Development	Pilot Scale
Major Raw Materials	Low grade Iron Ores, Flotation reagents
Major Plant Equipment/Machinery	Crushing, screening, scrubbing, classification, gravity separation, magnetic separation, froth flotation, dewatering, conveying systems
Details of specific application	The process is applicable to low grade iron ore, however, the process is to be tailored to suit specific ore application
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	The process is environment friendly. No toxic/ hazardous waste is discharged. Arrangement for tailings disposal is needed.
Patenting details	Nil
Commercialisation Status	The technology is sample specific being commercialized for ore from Bolani and Gua Mines of SAIL.
Techno-Economics	Available on demand
Key words	Low grade Iron ore, Gravity and Magnetic Separation, Iron Ore Beneficiation.

Process	Beneficiation of Low grade Baryte Ores
Area of Technology	Mineral Processing
Uses	The technology developed is for beneficiating of rejected low & lean grade baryte ores and the concentrate so produced is useful for oil drilling, barite chemical and other applications
Salient Features	While mining the barite high grade variety of above 4.1 to 4.35 sp.gr are taken separately for direct use after grinding. But the low grade below 3.9 sp. gr. is rejected. These low grade samples were processed for value addition. The process so developed basically involves crushing, classification, pre-concentration through jigging when material sp. gr. Is expected to be 4.1. When sp.gr. of more than 4.1 is required, the sample is subjected to flotation after grinding
Scale of Development	Pilot Scale
Major Raw Materials	Low grade baryte ores
Major Plant Equipment/ Machinery	Crushing, grinding, jigging, classification, gravity separation, flotation, dewatering
Details of specific application	Each process development is case specific and material specific
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	The process is environment friendly. No toxic/ hazardous waste is discharged
Patenting details	Nil
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Wolframite, Beneficiation, Chemical Processing

Process	Beneficiation of Low grade Tungsten Ores
Area	Mineral Processing
Uses	The technology developed is for beneficiating low & lean grade wolframite ores and the concentrate so produced is useful for defence and space applications, abrasive applications etc.
Salient Features	The process so developed basically involves crushing, classification, pre-concentration through dry magnetic separation, grinding, desliming, gravity and magnetic separation for preparation of an intermediate concentrate of about 25% WO_3. This concentrate is subjected to hydro & electrometallurgical route through roasting, leaching, solvent extraction to obtain a ammonium para-tungstate
Scale of Development	Pilot Scale
Major Raw Materials	Low grade wolframite ores
Major Plant Equipment/ Machinery	Crushing, grinding, cyclone, classification, gravity separation, magnetic separation, roasting, leaching set up and solvent extraction and stripping
Details of specific application	Each process development is case specific and material specific
Status of Development	The technology has been studied in pilot scale operation for low grade samples
Ecological/Environmental Impact (if any, specify briefly)	The process is environment friendly. No toxic/ hazardous waste is discharged
Patenting details	Not filed
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Wolframite, Beneficiation, Chemical Processing

Process	Clean Coal(Coking/Non-Coking)
Area	Mineral processing
Uses	For metallurgical use (coking), for direct reduction of iron ore, coal dust injection in blast furnace (non-coking)
Salient Features	The process is based on crushing, grinding and flotation of raw coal. Depending on the coal characteristics, a clean coal of 12% ash with 40-50% yield, 17% ash with 50-75% yield has been obtained for coking coal. For non-coking coal concentrates of 10-12% ash 40-65% yield have been obtained from a feed of 22.5-30% ash
Scale of Development	The process has been developed on 20 tpd scale
Major Raw Materials	Raw coal, Kerosene, Diesel oil, Pine Oil, Sodium silicate
Major Plant Equipment/Machinery	Crushers, Grinders, Flotation banks, Conditioners, Thickeners, Filters, Conveying equipment's, Pumps.
Details of specific application	For direct reduction of iron ore, coal dust injection in blast furnace
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	Installation of tailings disposal units will be needed
Patenting details	Nil
Commercialisation Status	Commercialised to few industries
Techno-Economics	Available on demand
Key words	Coking Coal, Non-coking Coal, Froth Flotation, Ash reduction

Process	Copper Concentrate from Copper Ores
Area	Metal Extraction, Non-Ferrous Metallurgy
Uses	The concentrate is used in flash smelters for extraction of copper in downstream metallurgical process
Salient Features	The process is based on forth flotation of copper bearing minerals from ore after milling. The concentrate is filtered, dried and sent to smelters
Scale of Development	The process has been developed on 24 tpd scale
Major Raw Materials	Copper Ore, Xanthates, Sodium Silicate and Soda Ash
Major Plant Equipment/Machinery	Crushers, Conveying equipment, Grinding mill and Classification circuit, Conditioners, Flotation banks, Thickeners, Filters, Dryers, Slurry and Water pumps, Water reclaimer
Details of specific application	Used in flash smelters for extraction of copper in downstream metallurgical process
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	There should be well planned disposal of wastes and effluents
Patenting details	Patent Filed
Commercialisation Status	(1) A 1000 tpd plant at Rakha Copper Project based on NML flowsheet. (2) 6000 tpd Malanjkhand copper project based on NML flowsheet.
Techno-Economics	Available on demand
Key words	Copper Concentrate, Copper Ores

Process	High Quality Magnesite (<2% silica)
Area	Mineral Processing
Uses	Refractories, glass and foundry industries
Salient Features	The Process is based on multiple stage froth flotation of milled feed followed by dewatering, drying and pelletisation / briquetting of magnesite concentrate
Scale of Development	The process has been developed at 25 tpd pilot plant level
Major Raw Materials	Magnesite ore, fatty acid, caustic soda, sodium silicate.
Major Plant Equipment/ Machinery	Crushers, Milling units, Flotation banks, pumps, Conditioners,Thickeners, Filters, Dryers, Pelletising Briquetting machine
Details of specific application	The Process is applicable to processing of low grade magnesite with siliceous impurities
Status of Development	Pilot scale
Ecological/Environmental Impact (if any, specify briefly)	Installation of tailings disposal system is needed
Patenting details	Nil
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Magnetite, Refractory uses, Froth flotation

Process	Pellets from iron ore fines/slimes
Area	Mineral Processing
Uses	In the Production of sinter / pellets for Iron ore and steel making
Salient Features	The process involves gridding, pelletization of beneficiated fines/slimes using suitable binder. The heat hardened pellet is suitable for iron making
Scale of Development	Laboratory Scale , Pilot Scale (under execution)
Major Raw Materials	Beneficiation iron fines/Slimes, Fluxes (Limestone, Dolomite or other Mg bearing minerals), Coke Breeze, Lime and Metallurgical Wastes
Major Plant Equipment/Machinery	Preparation and mixing circuits of major raw materials, disc/ drum pelletiser, heat hardening units
Details of specific application	The process can be used for utilization of low grade iron ore fines and slimes after beneficiation
Status of Development	Bench Scale
Ecological/Environmental Impact (if any, specify briefly)	The process is environment friendly.
Patenting details	Nil
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Iron ore, Pellets , Cold (Tumbler) strength, RDI and RI

Process	Phosphate Concentrate
Area	Mineral Processing
Uses	For the manufacture of phosphoric acid and phosphatic fertilizers
Salient Features	Phosphate rock is upgraded mainly by flotation and in some cases by high intensity magnetic separation to remove impurities
Scale of Development	The process has been developed at 20 scale. Specific adaptation to the ore may need additional tests
Major Raw Materials	Phosphate rock, flotation chemicals
Major Plant Equipment/Machinery	Crushers, Gridding mills, Flotation units, Thickeners, Filters, Dryers and high gradient Magnetic Separator depending on mineralogy of the rock
Details of specific application	The process can be applied for beneficiation low grade rode phosphate with silicate and iron impurities
Status of Development	Bench followed by pilot scale
Ecological/Environmental Impact (if any, specify briefly)	Arrangement of disposal of tailings and effluents is needed
Patenting details	Nil
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Rock Phosphate, Froth flotation, Phosphoric acid

Process	Recovery of metal values from waste printed circuit boards
Area	Waste Recycling
Uses	Electronic Waste Processing, Waste Utilisation
Salient Features	The components in e-waste containing metals are shredded and pulverized. The metals are separated from the plastics in the particulate mass using a series of physical processes. The process does not require specialized and sophisticated equipment for processing of waste printed circuit boards. All equipment and machinery required are standard and readily available worldwide. The natural hydrophobicity of non-metallic constituents is effectively exploited by wet flotation process A continuous operation at plant level will be able to minimize the loss of ultrafine metal values to a negligible level. The operation is simple and the overall processing cost is low as only inexpensive, physical separation processes are used. The techniques used are purely physical in nature and thus generate no additional harmful effluents. Enables the recovery of both the metallic and non-metallic constituents separately. Very little or no chemicals are used and therefore the cost effectiveness of the process is improved.
Scale of Development	About 1.0 ton scale.
Major Raw Materials	Scrap computers, end-of-life TV sets and mobile phone handsets
Major Plant Machinery	Shear/Shredding machine, Ball mill, Classifier, Equipment Gravity concentrator, Flotation cell, High tension separator
Details of specific application	The raw materials need to be ground to -1.0 mm in size. The pulverized particle mass is then treated using a series of physical separation methods to exploit the differences in the physical properties of the metals and the plastics. These are wet processes in the initial part of the flow sheet while the later processes are dry processes with a drying step in between. The application is essentially in the recycling of electronic waste.
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	The unit operations are physical processes and no chemicals are used. No adverse effect on environment.
Patenting details	Patent Application No. 0206/DEL/2007, Dated 25.01.2008
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Electronic Waste, Waste Recycling, Physical Separation, Metal Recovery

Process	Separation of Quartz & Feldspar
Area	Mineral Processing
Uses	Glass and Ceramic industries
Salient Features	The process is based on recovery of minerals by froth flotation. Differential flotation using a suitable reagent scheme is helpful in separation of quartz and feldspar from the ground one slurry
Scale of Development	Bench scale
Major Raw Materials	Ore/ Mica mine waste dump containing quartz and feldspar, flotation reagents
Major Plant Equipment/ achinery	Crusher, Grinding Mill, Classifier, Conditioner, Flotation cells, Dewatering Units
Details of specific application	Glass and Ceramic industries
Status of Development	Bench scale upto 10 Kg.
Ecological/Environmental Impact (if any, specify briefly)	Installation of tailings and effluent disposal systems is needed
Patenting details	Nil
Commercialisation Status	Ready for Commercialisation
Techno-Economics	Available on demand
Key words	Quartz, Feldspar, Froth Flotation , Mica Waste Dump

Process	Utilization of Iron Ore Slimes
Area of Technology	Mineral Processing, Ferrous Processes
Uses	In the production of sinter / pellets from the concentrates of Iron ore (slimes)
Salient Features	The concentrate generated from the beneficiation of slimes and lean grade ores need to be suitably agglomerated in the form of sinter or pellets for iron making through DR and / or BF route(s). Sinter-making using the concentrate from these resources is not a viable solution in view of its unfavourable granulometry. A suitable palletisation process has been developed which addresses the problem of higher requirement of binder. Besides, the process aims to generate quality pellets in terms of RDI/ RI and swelling index
Scale of Development	Laboratory Scale, Pilot Scale (under execution)
Major Raw Materials	Iron Ore Fines, Fluxes (Limestone, Dolomite or Other Mg bearing minerals), Coke Breeze, Lime and Metallurgical Wastes
Major Plant Equipment/Machinery	Preparation and Mixing Circuits of major raw materials, Disc/ Drum pelletiser, Heat hardening units
Details of specific application	IS 9963:1981 and IS 6495:1984, respectively, for the shatter and tumbler tests of pellets. RDI and RI tests follow standard measuring practice in Tata Steel or elsewhere
Status of Development	The technology, though successfully implemented in typical plant is material specific, hence the process need to be studied in our Laboratory in relation to the concentrates from the slimes and lean grade iron ore(s)
Ecological/Environmental Impact (if any, specify briefly)	The process is environment friendly
Patenting details	Nil
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Iron ore, Pellets , Cold strength, RDI and RI

Process	*In-situ* preparation of Alumina - (Ti, Zr) Borides Composite
Area	Materials science
Salient Features	The obtained composite has a very good density in the range of 93-97% of theoretical density and grain-growth could be controlled to very fine size for both alumina as well as borides in the range of 1-2 micrometer or less. A range of composition can be obtained by this process. It is a fast, cost effective and energy efficient process. It does not require any high temperature furnace. The present invention uses a novel dynamic SHS process to simultaneously synthesise and densify the composite using cheaper raw materials. The study has shown a newer way of making dense composite of Alumina-Boride matrix composite. The obtained composite has density in the range of 93-97% of theoretical density and grain-growth could be controlled to very fine size for both alumina as well as borides in the range of 1-2 micrometer or less. A range of composition can be obtained by this process
Scale of Development	Laboratory Scale
Major Raw Materials/Plant Equipment/Machinery	Zirconium Oxide, Boron Oxide, Aluminium, Titanium, Titanium Dioxide, Aluminium Oxide
Area of application	Such composites has applications in wear resistance, corrosion resistant, oxidation resistance, electrical, chemical, metallurgical, cutting tool applications, targets for composite coatings, etc.
Details of specific application	Crucibles, cutting tools, armors, electrodes, target for composite coatings by sputtering of wear resistant composite coatings
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Patent filed
Commercialisation Status	Ready for Commercialisation
Techno-economics	Available on demand
Key words	In-situ Composite, Alumina-Boride Composite, SHS

Process/product	Biphasic calcium phosphate nano-bio ceramic for dental and orthopedic applications
Area	Nano-materials, Advanced Materials
Uses	As a bone grafting material to be used for orthopedics
Salient Features	A biomimetic process for producing bioactive biphasic calcium phosphate nano-bioceramic (combination of hydroxyapatite and tri calcium phosphate in required stoichiometry) particles in the narrow size range of 80 nm - 100nm and uniform morphology
Scale of Development	Laboratory scale
Major Raw Materials	Hydrophilic synthetic / biopolymers, Ca and phosphate salts.
Major Plant Equipment/Machinery	Chemical Glass reactor with stirring facility, spray dryer andresistant heating furnace (1273K)
Details of specific application	Materials specification as per ASTM standards
Status of Development	Process flow sheet developed
Ecological/Environmental Impact (if any, specify briefly)	Ecofriendly process
Patenting details	Patent Filed
Commercialisation Status	Transferred to M/s Eucare Pharmaceuticals Pvt. Ltd. Chennai.
Techno-Economics	Available on demand
Key words	Nanobioceramics, Biphasic Bioceramics, Bioactive

Process	Development of Co free Diamond Polishing Wheel
Area	Diamond Industry
Uses	i) Polishing of diamonds ii) Polishing of microscopy samples
Salient Features	In India the Diamond Manufacturers either import the polishing wheels or they used Indian made polishing wheels which contains metallic Cobalt as a binder. The imported wheels are costly and Co is highly toxic to the workers engaged in polishing of diamonds. The NML developed polishing wheel are of low cost and Co-free
Scale of Development	The size required for diamond polishing industry
Major Raw Materials	Synthetic Diamond powder, Bronze powder and WC
Major Plant Equipment/ Machinery	Grinding & mixing equipment, Hot Press, Lathe Machine
Details of specific application	Mixing of raw materials, hot pressed of the composite mixture on the substrate of the wheel
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	It does not have any toxic metal / material and it is ecological and environmental friendly
Patenting details	Nil
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Diamond, Polishing

Process	Giant Magneto-Impedance (GMI) based magnetic sensing device for Non-Destructive Evaluation applications
Area	Non-Destructive Evaluation, Magnetic Sensor, Advanced Materials
Uses	To monitor the structural health of steel structures or components which are in-service and intended to use for an extended period during which various damages can be developed such as residual stress, fatigue, creep or the formation of magnetic phase in non-magnetic steel in non-destructive way
Salient Features	Giant magneto-impedance (GMI) based portable easy operable magnetic sensing device where nanostructured Fe-Co based magnetic wires of diameter 80-120 mm prepared by in-water quenching technique directly from melt is used as a core material in the probe-head. This core element within a primary coil is excited by a frequency ranging between 250 kHz and 1 MHz and initially balanced using a secondary coil and a balancing circuit in such a way that when the test object was placed close to the probe head, the signal generated has an amplitude depending on the microstructural condition of the test object. The novel feature of the invention lies in the construction of this sensing probe, proper positioning of the coils on the sensing core as well as the choice of the nanostructured wire shaped GMI materials
Scale of Development	Portable device
Major Raw Materials	Electronic components, Soft magnetic core materials
Major Plant Equipment/ Machinery	Sensing probe, power source, amplifier, Data acquisition & analysis system
Details of specific application	For determining spinning motion of non-ferrous body or using as a security sensor and proximity sensor
Status of Development	Prototype
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Patent Filed
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Magnetic sensor, Giant Magneto-Impedance, Non-Destructive Evaluation

Process	Co-Fe based nano crystalline ferromagnetic ribbons for high temperature soft magnetic applications
Area	Advanced Materials
Uses	The materials will be used in rotor assemblies as well as magnetic bearings of auxiliary power supplies in aircraft engines, high frequency transformers and space power systems which encounters high temperature during operation
Salient Features	CoFeSiBNb nanostructured alloy system prepared by melt spinning in the form of ribbons (thickness =30 - 35μm). After nanostructured formation by suitable annealing the materials will have Curie temperature ~1000K, coercivity ~ 600 mOe. High temperature soft magnetic applications are mostly catered by CoFe-based crystalline alloys. These materials have inferior soft magnetic properties. Hence, in addition to small amount of Cobalt, the element Nb was added to restrict grain growth during Amorphous to nanostructured transformation. The element Nb which stabilizes the amorphous state of the alloy demands less attention towards oxidation compared to the reported use of Zirconium.
Scale of Development	200gms-500gms
Major Raw Materials	Cobalt, Iron, Silicon, Boron and Niobium
Major Plant Equipment/Machinery	Vacuum Arc Melting system, Induction melting with melt spinning System.
Details of specific application	High frequency transformer, High temperature magnetic sensor
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Patent Application No. : 0893/DEL/2006, Dated 30.03.2006
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key Words	Amorphous Materials, Nanomaterials, Nanocrystalline Ferromagnetic Ribbons

Process	A Biomimetic Process for the synthesis of aqueous Ferro-fluids for biomedical applications
Area	Nano-biotechnology
Uses	As a biocompatible contrast agent in Magnetic Resonance Imaging (MRI), Magnetic Hyperthermia and targeted drug delivery
Salient Features	(i)Single-step synthesis at ambient conditions, (ii) Stable colloidal solution with particle size within 10-20nm and (iii) Good magnetic properties
Scale of Development	Laboratory scale
Major Raw Materials	Ferrous/ferric salts, biocompatible polymers, oxidising agent
Major Plant Equipment/ Machinery	Magnetic stirrer
Details of specific application	New process for aqueous Ferro fluids, no existing specifications
Status of Development	Process flow sheet developed
Ecological/Environmental Impact (if any, specify briefly)	Eco-friendly process
Patenting details	Patent Application No. 0672/DEL/2010, Dated 07.07.2010
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Aqueous Ferro Fluids, Biocompatible, Biomedical Applications

Process	Magnetic non-destructive evaluation (NDE) device for assessment of damage in service exposed steel component
Area	Non-destructive Evaluation, Magnetic Sensor
Uses	Damage assessment in service exposed steel component
Salient Features	The microstructural degradation that takes place during service is a measure of damage accumulation in materials. Metallographic techniques are available for evaluation of microstructural degradation. However, the in-situ metallographic technique used for assessing in-service component is tedious, time consuming and most of the time cannot be assessed immediately. The present technique involves early detection of damage by significant change in magnetic property of steel structure/component. The developed magnetic NDE technique is suitable to use on-site to assess the extent of damage accumulation in components after extended period of service at high temperature
Scale of Development	Prototype have been designed
Major Raw Materials	Electronic components, Soft magnetic core materials
Major Plant Equipment/ Machinery	Sensing probe, power source, amplifier, Data acquisition & analysis system
Details of specific application	Process heater tubes, steel undergoing magnetic transformation during service, Residual stress in components, Sorting of ferritic steel components
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	No environmental impact
Patenting details	US Patent No: 6617847
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Magnetic Evaluation, Service Exposed Steel Structure, Damage Assessment, Non-destructive Evaluation

Process/Device	A portable magnetic sensing device for non-destructive evaluation (NDE) of damage in service exposed steel structures/components
Area of Technology	Non-Destructive Evaluation
Uses	The microstructural degradation that takes place during service is a measure of damage accumulation in materials. Metallographic techniques are available for evaluation of microstructural degradation. However, the in-situ metallographic technique used for assessing in-service component is tedious, time consuming and most of the time can not be assessed immediately. Good laboratory and expert personnel is required for interpreting the result. The present technique involve early detection of damage by significant change in magnetic property of steel structure/ component
Salient Features	The developed magnetic NDE device works by exciting magnetic sensor using an alternating current source or signal generator followed by a power amplifier. The signal generator works within the frequency range of 5mHz to 150Hz. The magnetic sensor is to be placed on test body to get signal corresponding to the characteristics of the test objects. The output signals from the sensor are the measure of the magnetisation, coercivity and magnetic noise (Barkhausen emissions) which changes with microstructure and stress state of the materials. Hence the magnetic signals from the sensor are relateed to the damage state of the test object
Scale of Development	Portable device
Major Raw Materials	Electronic components, Soft magnetic core materials,
Major Plant Equipment/ Machinery	Sensing probe, power source, amplifier, Data acquisition & analysis system
Details of specific application	Process heater tubes, steel undergoing magnetic transformation during service, Residual stress in components, Sorting of ferritic steel components
Status of Development	Prototype
Ecological/Environmental Impact (if any, specify briefly)	Nil
Patenting details	Patent Application No.: 2545/DEL/2006
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Magnetic Evaluation, Service Exposed Steel Structure, Damage Assessment, Non-Destructive Evaluation

Process/Product	Biomimetic nano bioceramics for bone graft
Area of Technology	Nano-materials, Advanced Materials
Uses	As a bone grafting material used for orthodontics
Salient Features	Single-step biomimetic synthesis at ambient conditions capable of producing hydroxyapatite particles in the narrow size range of 80nm - 100nm and uniform morphology
Scale of Development	Laboratory scale
Major Raw Materials	Hydrophilic synthetic / biopolymers, Ca and phosphate salts.
Major Plant Equipment/Machinery	Chemical Glass reactor with stirring facility and spray dryer
Details of specific application	Materials specification as per ASTM standards
Status of Development	Process flow sheet developed
Ecological/Environmental Impact (if any, specify briefly)	Ecofriendly process
Patenting details	Patent Filed
Commercialisation Status	Commercialized to M/s Eucare Pharmaceuticals, Pvt. Ltd. Chennai
Techno-Economics	Available on demand
Key words	Nano Bioceramics, Hydroxyapatite

Process	Fabrication of tailored hardness nano-composite coating with low coefficient of friction
Area	Advance Materials, Nano-materials
Uses	Wear resistance, oxidation resistance, automobile, cutting tool, can be applied to steel, aluminium alloys, Ni-base super alloys, titanium alloys, glass, silicon
Salient Features	The present invention relates to the fabrication of tailored hardness nano-composite coating with low coefficient of friction. The present invention particularly related to the fabrication of nano-composite coatings with tailored hardness between 10 to 50Gpa with lower coefficient of friction between 0.1 to 0.2 consisting of transition metal element and other element borides, carbides and nitrides by sputtering process from single target. This invention also relates to reproducible and plasma based process on different kind of substrates having amorphous matrix with nano-crystalline phases in the range of 2-100nm. The hardness of the coatings can be tailored from low to hard hardness (10 to 50 GPa) for different applications
Scale of Development	Laboratory scale
Major Raw Materials	Carbide, borides
Major Plant Equipment/Machinery	Sputtering unit, press for sputtering target making
Details of specific application	Wear resistance, oxidation resistance, automobile, cutting tool
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Patent Application No. 0770DEL2010
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Nano Composite Coatings, Wear Resistant Coatings, Automobile Coatings, Cutting Tools, Sputtering

Process/Device	A portable stress strain measuring system using automated Ball Indentation technique
Area	Non-destructive Evaluation
Uses	To evaluate key mechanical properties of metallic components/ materials
Salient Features	Can be used for in-situ application. It requires small amount of test materials for laboratory application. Fabrication of complicated test specimen as required in conventional test can be avoided. It relatively rapid compared to conventional BI test.
Scale of Development	Full scale Equipment
Major Raw Materials	NA
Major Plant Equipment/Machinery	NA
Details of specific application	Available on demand
Status of Development	Complete
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Patent/Copyright filed/registered
Commercialisation Status	Technology has been transferred to few industries
Techno-Economics	Available on demand
Key words	Ball Indentation, Mechanical Properties, PABI

Process	Rejuvenation of Hot-gas path components of gas turbine
Area	Gas Turbine
Uses	Rejuvenation of hot gas path components of gas Turbine viz. Turbine rotor blades, nozzle guide vanes, transition pieces, combustion chamber
Salient Features	Realistic assessment of damages incurred and recovery of damages in hot gas path components of gas turbine plays an important role in turbine condition-based maintenance and overhaul. The technology aims to recover the original microstructure and high-temperature mechanical properties of engine run components by a series of heat treatment and hot-isostatic procedures to recover/regenerate the hot gas path components made of various grades of super alloys. The technology is alloy specific. The technology for alloys:In738,GTD-111, U-520 has been implemented to various gas turbines of NTPC
Scale of Development	Laboratory Scale
Major Raw Materials	Knowledge and data base generated on the super alloys over a period of service exploitation
Major Plant Equipment/ Machinery	Heat Treatment and HIPPING furnaces, Microstructural tools, creep/stress rupture machines.
Details of specific application	Rejuvenation of engine-run hot gas-path components of gas turbines.
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Nil
Commercialisation Status	Implemented to various NTPC Units
Techno-Economics	Available on demand
Key words	Rejuvenation, Nickel base Super Alloy, Hot Gas Path Components, Rotor Blades, Guide Varies

Process	Development of manufacturing technology for production of wide metallic glass ribbon
Area	Manufacturing Technology, Advanced Materials
Uses	For the preparation of low cost ferromagnetic alloys used in magnetic cores for sensor applications and also for the development of high frequency transformers, magnetic heads, saturable reactors, choke coils etc.
Salient Features	The major problem of getting continuous wider metallic glass ribbon is the instability of the melt puddle and maintaining the quenching rate without heating of the copper wheel during melting of the master alloy. In the developed technology, melt puddle stability was achieved through a flexible crucible positioning system. Continuous ribbons of nearly 1 Kg materials with more than 25mm width and 30micron thickness can be prepared directly from melt. The product does not need any expensive forging and rolling operation. Duration of melt-spinning to get about 1kg product (after melting of the alloy) is less than a minute and hereby power requirement during production is less. Fe-,Co-, Ni- based product have excellent magnetic properties with the coercivity ~ mOe
Scale of Development	Bench Scale
Major Raw Materials	Fe, Co, Ni, Cr, Nb, Cu, Si,B, Al, Mg, Zr
Major Plant Equipment/ Machinery	Electric Arc Furnace, Melt Spinner
Details of specific application	Transformer core, switch mode power supply, sensor materials, High strength Al and Mg based ribbon as protective materials, brazing alloys (CuNi, TiZr).
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Patent Application No: 0522/del/2008, 05.03.2008
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Melt Spinning, Rapid Solidification, Metallic Glass, Nanostructure Materials

Process	An improved process for the preparation of Zirconium Diboride powder
Area	Advanced Materials
Uses	The process uses novel SHS process using oxides or salts as raw material. The process is fast, energy and cost effective to produce zirconium diboride powder
Salient Features	The obtained powder is 95% and above pure with a very high surface area having particle sizes in sub-micrometer range. The process is fast, energy and cost effective to produce zirconium diboride powder. It does not require any high temperature furnace
Scale of Development	Laboratory Scale
Major Raw Materials	Zirconium compounds, Oxides, Boric Acid, Boron Oxide
Major Plant Equipment/ Machinery	Furnace
Details of specific application	Electrode for Al production, High temperature crucibles, wear resistant parts, cutting tools
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Patent filed
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Borides, High Temperature Material, Non-oxide Ceramics, SHS

Process	Column Flotation for the Beneficiation of Low-Grade and Finely Disseminated Ores.
Area	Mineral Processing
Uses	(i) Enrichment of ores by flotation, (ii) Flotation of ores and minerals, (iii) Quality and quantity improvement in mineral processing circuits, (iv) Flotation of base metal ores (Cu, Pb, Zn ors), iron ores (hematite, magnetite, BHQ, etc.), beach sand minerals (sillimanite) & industrial minerals (limestone, barite, etc.)
Salient Features	The merits of the flotation column includes improved metallurgical performance in terms of grade and recovery, effective cleaning action, smaller floor space, low capital investment, less operational and maintenance cost and easier control. Improved metallurgical performance is assured by column flotation as a result of (i) Less entrainment and entrapment through froth washing, (ii) Independent control of operating variables, (iii) Flotation of course and slimes particles, (iv) Can also be used as roughers and scavengers. Reduced running costs as a result of (i) No moving parts, (ii) Lower reagent consumption, (iii)Lower energy consumption. Reduced capital costs as a result of (i) Lower residence time, (ii) Higher gas holdup, (iii) Substantial reduction in floor area and (iv) One stage of column flotation is equivalent to 3 stage conventional flotation
Scale of Development	Pilot Scale
Major Raw Materials	Pilot Plant Facility
Major Plant Equipment/Machinery	Column with variable height, Indigenous sparging system, Microprocessor based level control, Auto pneumatic sampling, Digital flow measuring systems - air, water, feed, Centralized control panel
Details of specific application	For the beneficiation of Low-Grade and finely disseminated ores.
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Patent Filed
Commercialisation Status	Laboratory scale - 74mm diameter- 10kg/h treatment capacity (4 Nos. at NMLMC, NML-JSR, GVIT-Kolar & NEIST-Jorhat). Pilot scale - 500mm diameter-1ton/h capacity (2 Nos. At NMLMC & RBSSN-Hospet, for low-grade iron ore) Commercial scale - 1250mm diameter-150TPD capacity (Installed 3 Nos. at IREL-Chatrapur, Orissa, for sillimanite; Calpro-Salem, for limestone & IREL-Chavra, Kerala, for sillimanite). Installation of a 2500mm diameter column for the beneficiation of barite is in progress at Mangampet, A P.
Techno-Economics	Available on demand
Key words	Column Flotation, Beneficiation, Mineral Processing

Process	Electroless nickel alloy and composite plating
Area	Surface Engineering
Uses	Corrosion and Wear resistant coatings
Salient Features	High hardness of the order of 600 HV0.2 in as-plated condition, excellent wear resistance, very good corrosion resistance in acid and saline environments
Scale of Development	Laboratory and Pilot scale
Major Raw Materials	Nickel salts, reducing agents, complexing agents, stabilizers, special Additives, alkaline solution
Major Plant Equipment/Machinery	Direct current source (Rectifier) having a potential range of 0-60 V, Heating coils and control systems, Sparger tubes and compressor, Tanks made of polypropylene for cleaning, pre-treatment, plating and rinsing, Exhaust systems, Conveyor systems
Details of specific application	Corrosion and Wear resistance for engineering, automotive, textile, components
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	Acidic solutions. They should be neutralized before discharge. Nickel salts, reducing agents and stabilizers need to be treated properly before discharge
Patenting details	Nil
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Electroless Plating, Composite Coating, Corrosion Resistance, Wear Resistance

Process	Electrolytic colouring of titanium and its alloys
Area	Surface Engineering, Anodization, Metal Finishing
Uses	Colour coding of electronic components, Jewellery applications (for aesthetics)
Salient Features	A variety of colours can be imparted on the surface of titanium and its alloys by suitably varying the operating conditions. The coating is uniform, adherent and abrasion resistant
Scale of Development	Pilot scale
Major Raw Materials	Ti and its alloys, mineral acids, fluorides and special additives
Major Plant Equipment/Machinery	Direct current source (Rectifier) having a potential range of 0-60 V Stainless steel cathodes of suitable geometry Cooling systems
Details of specific application	Colour coding of electronic components and Jewellery applications
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	Acidic solutions. They should be neutralized before discharge.
Patenting details	Nil
Commercialisation Status	Ready for Commercialisation
Techno-Economics	Available on demand
Key words	Titanium, Titanium Alloys, Electrolytic Colouring, Colour Coding

Process	Electrolytic reactor for purification of industrial effluents
Area	Waste Utilization
Uses	For purification of effluents from tannery, textile, restaurants, paint and printing
Salient Features	The electrolytic reactor is useful for the purification of industrial effluents / wastewater generated from tanneries, textile units and metal finishing & processing industries. The dissolved inorganic and organic pollutants and suspended solids can be removed. Even colloidal particles could be effectively coagulated and separated by floatation. Most of the water can be recovered and reused. Easy construction, separation is faster compared to conventional coagulation and floatation. Even colloidal particles could be effectively coagulated and separated. Dissolved organics could be mineralized without the addition of oxidants externally
Scale of Development	Pilot Scale
Major Raw Materials	Effluents from tannery, textile, restaurants, paint and printing
Major Plant Equipment/Machinery	Electrolytic reactor, Separator
Details of specific application	For purification of industrial effluents.
Status of Development	Pilot scale test reactor was designed and extensively field tested for the treatment of tannery effluents.
Ecological/Environmental Impact (if any, specify briefly)	Since the electron is the main reagent, the secondary contamination could be avoided by electrocoagulation. The oxidants ozone, hypochlorite and Fenton reagent, nascent oxygen necessary for the mineralization of organic compounds could be generated insitu
Patenting details	Patent Filed
Commercialisation Status	Ready for Commercialisation
Techno-Economics	Available on demand
Key words	Electrochemical Reactor, Wastewater, Effluent, Floatation

Process	Removal of pollutants from industrial effluents by electrochemical technology
Area	Environmental Pollution
Uses	Removal of pollutants from wastewater
Salient Features	Micron size and sub micron size particles including low density fats and proteins dispersed in water can be easily separated. Dissolved organic compounds in water can be effectively oxidized and removed The advantages of the process are (i) no need for external addition of oxidizing agents/chemicals, (ii) require less space and easy construction, (iii) pathogenic bacteria present in wastewater can be Simultaneously eliminated and (iv) the resultant water can be recycled
Scale of Development	Pilot scale ($1M^3/h$)
Major Raw Materials	Aluminum rods and plates, steel rods and plates, stainless steel and Ti based rods and plates, perspex or poly propylene sheet
Major Plant Equipment/Machinery	Conditioner, pumps, rectifier/DC Power supply unit, Valves
Details of specific application	Purification of wastewater
Status of Development	Pilot plant was designed and the technology was demonstrated in the tannery industries situated in Ambur, Erode and Chennai.
Ecological/Environmental Impact (if any, specify briefly)	No
Patenting details	Patent filed
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Suspended Solids, Electrocoagulation, Electro-oxidation, Wastewater Treatment, Effluents

Process	TiO_2 nanotubular arrays on Ti and its alloys
Area	Surface Engineering
Uses	(i) Dye sensitized solar cells, (ii) Controlled drug delivery Biomedical applications (iii) Sensors and (iv) Self-cleaning photo catalytic surfaces and devices
Salient Features	TiO_2 nanotubular structure with varying tube length and diameter with high aspect ratio can be prepared on the surface of Ti and its alloys by using optimum electrochemical treatment
Scale of Development	Laboratory scale
Major Raw Materials	Ti and its alloys, mineral acids, fluorides and special additives
Major Plant Equipment/Machinery	Direct current source (Rectifier) having a potential range of 0-60 V, stainless steel cathodes of suitable geometry, Cooling systems
Details of specific application	Solar cells, drug delivery, sensors, etc.
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	Acidic solutions. They should be neutralized before discharge.
Patenting details	Nil
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Titanium, Titanium Alloys, Nanotubular Structure, Anodization, Drug Delivery, Solar Cells, Implant Applications

Process	Zero waste phosphating process
Area	Metal Finishing, Surface Engineering
Uses	Pre-treatment for paint coating and Corrosion Protection
Salient Features	No solid or liquid waste is generated in the process, Contains no toxic chemical accelerators, Energy efficient and eco-friendly, Continuous operation with easy replenishment and control, Composite coating offers corrosion protection by barrier layer and sacrificial protection mechanisms
Scale of Development	Pilot scale
Major Raw Materials	Mineral acids, consumable anodes
Major Plant Equipment/Machinery	Direct current source (Rectifier) having a potential range of 0-60 V Metal anodes of suitable geometry
Details of specific application	Pre-treatment for paint coating, Corrosion protection
Status of Development	Completed
Ecological/Environmental Impact (if any, specify briefly)	Acidic solutions. They should be neutralized before discharge.
Patenting details	Nil
Commercialisation Status	Ready for commercialisation
Techno-Economics	Available on demand
Key words	Phosphate Coating, Composite Coating, Zero Waste Process, Corrosion Protection

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