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(DELHI CHAPTER)

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INTRODUCTION

This News Letter is containing briefs on third Executive Committee Meeting for the year 2010-11 and an obituary message of Late Shri V R Subramanaian, Ex-Chairman of IIM-DC.

The News Letter contains the following Technical Write-ups:

1. "Nanostructured Materials: Synthesis, Characterization, Properties and Applications" by Dr. A K Srivastava, Member IIM-DC & Technical & Publication Committee.

2. "Raw Material Scenario for Indian Steel Industry-Some Key Issues" by Shri S C Suri, Life Fellow, IIM & Chairman, Technical & Publication Committee, IIM-DC.

Briefs on the conference/summit - Conference on Awareness and Capacity Building in Sustainable Energy organized by Dr (Mrs) Malti Goel, Center of Studies in Science Policy, JNU, New Delhi 110067 and 4th India Energy Summit organized by Indian Chamber of Commerce (ICC) also find place in this News Letter.

The News Letter also contains National and International news relating to Ferrous & Non-Ferrous Sectors.

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OBITUARY

V.R. Subramanian, former Executive Director, India Lead Zinc Development Association passed away in sleep during the early hours of 17 August 2010. A physicist-turned metallurgist, Mr. Subramanian began his career in Indian Oxygen Ltd till 1978 when he took over the leadership of ILZDA. He not only gave stable and dynamic leadership but also made immense contributions towards the growth of the Indian steel and non-ferrous metals sectors in general and lead –zinc industry in particular. He organized many successful national and international technical conferences that led to the growth of the lead –zinc using industry. Mr. Subramanian was associated with various professional bodies like The Indian Institute of Metals, Indian Institute of Welding, Powder Metallurgy Association of India, Institute of Standards Engineers, American Society of Metals etc.

Mr. Subramanian received the Life Time Achievement Award from the Indian Institute of Welding. Mr. Subramanian was also made the Honorary Member of The Indian Institute of Metals during 2006-07, in view of his very significant contributions to the Indian metals industry; played a crucial role in national standardization activities too. A very widely travelled scholar, he leaves behind his wife, son and daughters. May his soul rest in eternal peace!

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Chapter News

Executive Committee Meeting

The third EC meeting was held on 31st July 2010. The EC decided to carry out some repair works outside the building periphery to stop the water seepage inside the UNDP basement area. It was also agreed to carryout the repair of pump-house as suggested.

Conference on Awareness and Capacity Building in Sustainable Energy

Global warming and climate change are greatest environmental challenges for the humanity in the current century. In India the electricity generation is predominantly based on fossil fuels, having a share of 69% in the total installed capacity. Accelerated growth in energy demand is on the anvil in order to meet the basic energy needs of people. In this backdrop, a conference on Awareness and Capacity Building in Sustainable Energy (ACBSE – 2010) has been organized. Coordinator Dr. (Mrs.) Malti Goel (Center for Studies in Science Policy, JNU) introduced the conference and pointed out that sustainable energy growth is vital for the India's future economy. Two members of IIM-DC attended this conference.

The following two sessions were organized during the conference:

Session 1: Climate Change and Sustainable Energy

Session 2: Beyond Carbon Capture: Science of Geo-modeling Studies

Courtesy: Dr. (Mrs.) Malti Goel
JNU, New Delhi &
Member Tech. & Publication committee, IIM-DC

Fourth India Energy Summit

Indian Chamber of Commerce (ICC) in collaboration with the Ministry of New and Renewable Energy and Ministry of Power, Government of India organized the 4th India Energy Summit on August 23rd and 24th at Hotel Hyatt Regency, New Delhi. The focus was on Climate Change and energy challenge: A Pragmatic approach for India.

Shri S.C. Suri, Dr. (Mrs.) Malti Goel, Shri P. K. Chatterjee, Shri Neeraj Gupta, Shri Anil Gupta and Shri G. D. Renwal, actively participated in the summit. The subjects of Probability of Energy Crunch, the Catch 22 situation of pollution versus necessary power generation from coal based plants and Indian Energy policy were discussed. Addresses by Mr. Deepak Gupta (Secretary, MNRE, GOI) and Mr. B.K. Chaturvedi (Special Guest and Member of Planning Commission of India) followed.

Honorable Shri Sunil Kumar Shinde, (Union Minister for Power) was the Chief Guest and he delivered an informative speech. He said that the Generation capacity of India presently stands at 1,62,000 MW and during the 11th Five year plan 85% of the stipulated target for capacity addition in power sector is likely to be achieved.

Mr. Neeraj Gupta of our chapter informed the house about the far greater GHG effect of Methane compared to Carbon di oxide and this was well received by the house. He also enquired from Mr. Rajeev Singh to develop ICC as a platform for analyzing the needs of the rapidly developing power producing industry with respect to metals, alloys and machining capabilities. Mr. Singh has promised to look into this matter during another conference to be held in January, wherein IIM-DC members should take active part.

The second day saw deliberations on Non conventional and renewable Energy Resources. Where it was repeatedly stressed that the Sun will glow and the wind will blow and these resources are to be fully harnessed.

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Nanostructured Materials: Synthesis, Characterization, Properties and Applications

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The rapid development in the field of nano science and nanotechnology has driven a tremendous interest in understanding more and more about the behavior of materials at nano- and subnano- scale. Materials selection and synthesis techniques are major prerequisites for best achievement in this fast growing field. Moreover in depth characterization, optimization of process parameters and subsequent potential applications, make this area of research a very challenging task. This chapter provides information on some of the important nanomaterials, various methods of preparation, tools for characterization and a brief about usage of such fascinating nano-scaled objects.

Definition and initial research

The prefix 'nano-' comes from a Greek word which means dwarf. In science nano means a measure of 10^{-9} units. Both the small size and engineered structure of nanomaterials may create specific properties which distinguish them from other materials with a different particle size or structure and thus characterize nanomaterials. Over the past decade, nanomaterials have been the subject of enormous interest. These materials, notable for their extremely small featured size, have the potential for wide-ranging industrial, biomedical, and electronic applications. Table 1 illustrates examples of few nanostructures based on their dimensions.

Nanowires can be potentially used in nanophotonics, laser, nanoelectronics, solar cells, resonators and high sensitivity sensors. Nanoparticles can be potentially used in catalysts, functional coatings, nanoelectronics, energy storage, drug delivery and biomedicines. Nanostructured thin films can be used in light emitting devices, displays and high efficiency photovoltaics. These are only a limited part of the fast developing nanotechnology, yet numerous of other potential applications of nanomaterials have already been or will be discovered. Nanomaterials can be metals, ceramics, polymeric, or composite materials. Their defining characteristic is a very small featured size in the range of 1-100 nanometers (nm). The term nanomaterials covers various types of nanosturctured materials which posseses at least one dimension in the nanometer range. One nanometer spans 3-5 atoms lined up in a row. By comparison, the diameter of a human hair is about 5 orders of magnitude larger than a nanoscale particle.

Nanomaterials are not simply another step in miniaturization, but a different arena entirely; the nanoworld lies midway between the scale of atomic and quantum phenomena, and the scale of bulk materials. At the nanomaterial level, some material properties are affected by the laws of atomic physics, rather than behaving as traditional bulk materials do.

Table 1. Typical nanostructures [Zhao *et al.* 2000]

Different nanostructures	Size (approx.)	Materials
(a) Nanocrystals and clusters (quantum dots) Other nanoparticles	Diameter 1-10nm Diameter1-100nm	Metals, superconductors, magnetic materials Ceramic oxides
(b) Nanowires Nanotubes	Diameter1-100nm Diameter1-100nm	Metals, semiconductors, oxides, sulfides, nitrides Carbon, layered metal chalcogenides
(c) 2-dimensional arrays (of nanoparticles) Surfaces and thin films	Several nm^2 –μm^2 Thickness 1nm - 1000nm	Metals, semiconductors, magnetic materials Various materials
(d) 3-dimensional structures (super lattices)	Several nm in all 3 dimensions	Metals, semiconductors, magnetic materials

Although widespread interest in nanomaterials is recent, the concept was raised over 40 years ago. Physicist Richard Feynman delivered a talk in 1959 entitled "There's Plenty of Room at the Bottom", in which he commented that there were no fundamental physical reasons that materials could not be fabricated by maneuvering individual atoms. Nanomaterials have actually been produced and used by humans for hundreds of years - the beautiful ruby red color of some glasses is due to gold nanoparticles trapped in the glass matrix. The decorative glaze known as luster, found on some medieval pottery, contains metallic spherical nanoparticles dispersed in a complex way in the glaze, which gives rise to its special optical properties. The techniques used to produce these materials were considered trade secrets at the time, and are not wholly understood even now.

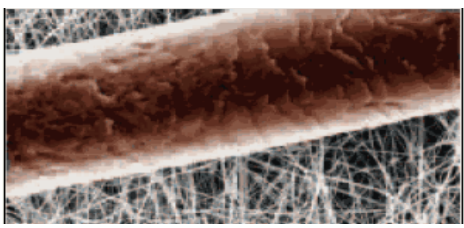

Fig.1: A picture of nanofibrils shown witha human hair [Hickman *et al.* 1991 Service *et al*. 2001]

Development of nanotechnology has been spurred by refinement of tools to see the nanoworld, such as more sophisticated electron microscopy and scanning tunneling microscopy. By 1990, scientists at IBM had managed to position individual Xenon atoms on a Nickel surface to spell out the company logo, using scanning tunneling microscopy probes, as a demonstration of the extraordinary new technology being developed [Hickman *et al.* 1991, Service *et al.* 2001].

In the mid-1980s a new class of materials - hollow carbon spheres - was discovered. These spheres were called buckyballs or fullerenes [Kroto *et al.* 1985, Lu *et al*. 2005], in honour of architect and futurist Buckminster Fuller, who designed a geodesic dome with geometry similar to that found on the molecular level in fullerenes. The C_{60} (60 carbon atoms chemically bonded together in a ball-shaped molecule) buckyballs inspired research that led to fabrication of carbon nanofibres, with diameters under 100 nm. In 1991 S. Iijima of NEC in Japan reported the first observation of carbon nanotubes.

The fullerenes are a class of allotropes of carbon which conceptually are graphene sheets rolled into tubes or spheres. These include the carbon nanotubes which are of interest both because of their mechanical strength and also because of their electrical properties [Kroto *et al.* 1985, Lu *et al.* 2005]. Another class of materials with nanometer-sized building blocks – mostly crystallites – as displayed in Fig. 4 may differ in their crystallographic orientation.

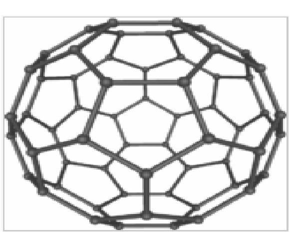

Fig.2:Buckminster fullerene C_{60} [Kroto *et al.* 1985]

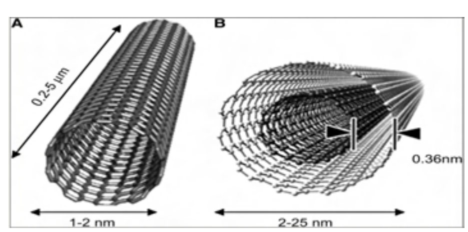

Fig.3: Carbon Nanotubes [Wikepedia]

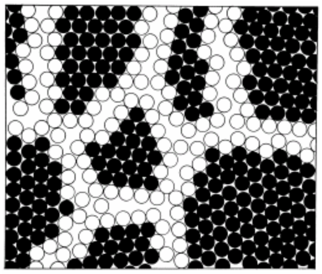

Fig. 4:
Two-dimensional model of a nanostructured material. The atoms in the centers of the crystals are indicated in black. The ones in the boundary core regions are represented as open circles [Gleiter *et al.* 2000].

Synthesis of nanomaterials

There are a large number of techniques available to synthesize different types of nanomaterials in the form of colloids, clusters, powders, tubes, rods, wires, thin films etc. Some of the already existing conventional techniques to synthesize different type of materials are optimized to get novel nanomaterials and some new techniques have been developed. Nanotechnology is an interdisciplinary subject. There are therefore various physical, chemical, biological and hybrid techniques available to synthesize nanomaterials. It can be seen from the following chart that, for each type, there is a large number of possibilities. The list continues to grow but the chart gives some commonly used techniques. The technique to be used depends upon the material of interest, type of nanostructure viz. zero dimensional (0-D), one dimensional (1-D), two dimensional (2-D) material, size, quantity etc.

Synthesis

Physical

Chemical
Colloids, sol-gels, L-B films, Inverse micelles

Biological
Using biomembranes, DNA, enzymes and micro organisms

Hybrid
Electrochemical, Chemical vapor deposition, Particle arresting in glass or zeolites or polymers, Micro emulsion

Mechanical
High energy ball Milling, melt mixing

Vapor
Physical vapor deposition
Laser ablation, Sputter deposition,
Electric arc deposition, ion implantation

In general, thin film deposition technologies can be divided in two groups. Categorically these techniques are: (i) Depositions that happen because of a chemical reaction, e.g. Chemical Vapor Deposition (CVD), for ex. Electro Deposition, Epitaxy, Thermal oxidation and (ii) Depositions that happen because of a physical reaction e.g. Physical Vapor Deposition (PVD), Casting, etc.

Oxide nanomaterials

Nanomaterials research has witnessed an exponential growth during the last decade. In the nanometric range, metallic and small band gap semiconducting materials exhibit fascinating quantum phenomena. Large band gap materials such as oxides stabilize in their high temperature phases and exhibit enhanced surface phenomena like catalysis and reduced reaction barriers for solid-state reactions. Indeed, in the nanometric range, materials may be expected to behave quite differently from both molecular and bulk states since the ratio of the number of surface atoms to the number of bulk atoms is quite high. As a consequence of this increased ratio the number of valence unsatiated atoms in the nanoparticle becomes significant. There is thus a curiosity to understand the behavior of materials in the nano length scale and if possible to exploit the new properties exhibited by materials purely as a consequence of the smallness of size. Nano oxide materials have found wide range of applications particularly as catalysts and as starting materials for making advanced structural ceramics. During sintering and shaping of oxidic materials for practical applications, use of nano-sized particles as starting materials can be of great advantage because of the availability of large surface areas of the nanoparticles. It may be noted that surface area of particles for a given quantity of the material scales as $1/\langle d \rangle$. Where $\langle d \rangle$ is the average diameter (linear dimension) of the particles. Most common oxide nanomaterials are MgO, NiO, CdO, ZnO, WO_3, TiO_2, Al_2O_3, Fe_2O_3 and ZrO_2. As an illustrative example, some of these nanostructures are elaborated here. Among these, CdO is a unique material possessing novel electrical, mechanical and optical properties [Cruz *et al.* 2005]. In brief CdO has a cubic (NaCl type, fcc; a = 0.469 nm) crystal structure with alternating Cd and O atoms located at lattice points. It is a brown colour solid with a high density (8150 kg.m^{-3}) and melting point (1500°C). It is a wide direct band gap (2.4 eV) semiconductor with an indirect gap of 1.36 eV. It is a promising candidate for optoelectronics, solar cells, phototransistors, photodiodes, transparent electrodes and gas sensors. Dimensional reduction of such materials results to improved non-linearity controlled by the quantum size effects and other mesoscopic influences. So far pertaining to fine microstructural objects, only the random – shaped particles and a limited work on epitaxial growth of CdO are attempted [Ma et al 2003, Mane et al. 2006]. Unfortunately not much work has been done on CdO due to its toxic nature. Investigations on different scale microstructures, respective morphologies and crystallographic interpretations of ultra-fine CdO are still warranted. The current work envisages a detailed microscopy and spectroscopy of thermally evaporated CdO.

Owing to the semiconducting, piezoelectric and pyroelectric nature of ZnO, its nanostructures have promising applications in nanoscale device fabrication of electronics, optics, optoelectronics, actuators and sensors. At nano-level novel electrical, mechanical, chemical, and optical properties are believed to be the result of surface and quantum confinement. ZnO is a direct wide bandgap (~ 3.3 – 3.6 eV) compound (II-VI) semiconductor with high exciton binding energy (~ 60 meV). It is understood to have the richest family of nanostructures, which includes nanowires, tetrapods, nanobelts, nanocombs, nanorings, nanohelixes nanocages etc [Huang *et al.* 2001, Wang *et al.* 2004, Srivastava *et al.* 2007]. The strong exciton binding energy (~ 60 meV) is substantially larger than that of GaN (25 meV) & ZnSe (22 meV) and the thermal energy at room temperature (26 meV) can ensure an efficient exciton emission at room temperature under low excitation energy. As a consequence, ZnO is recognized as a promising photonic material in the blue – ultra violet (UV) region.

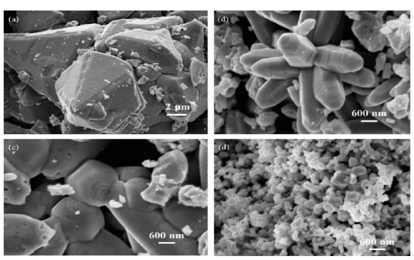

Fig. 5:
SEM micrographs of (a) undoped, (b) 0.5 mol%, (c) 2 mol% and (d) 50 mol% Fe doped ZnO samples [Srivastava *et al.* 2009]

Nature produces interesting oxides like alumina where small impurities of other elements lead fascinating optical properties in addition to various other physical and mechanical usefulness. Alumina is widely distributed in nature. Combined with silica and other minerals it occurs in clays, feldspars, and micas. Its most significant use is in the production of aluminum metal, although it is also used as an abrasive due to its hardness and as a refractory material due to its high melting point. Corundum is the most common naturally occurring crystalline form of aluminum oxide. Much less-common rubies and sapphires are gem-quality forms of corundum, which owe their characteristic colors to trace impurities in the corundum structure. Rubies are given their characteristic deep red color and their laser qualities by traces of the metallic element chromium. Sapphires come in different colors given by various other impurities, such as iron and titanium.

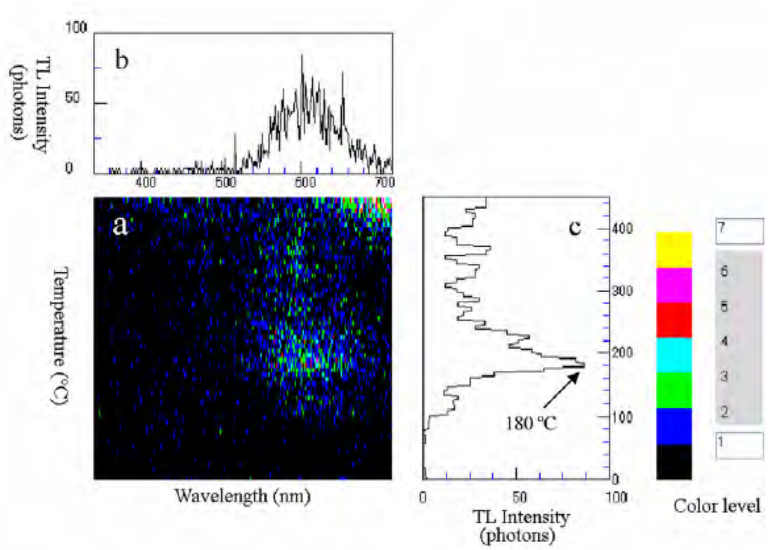

Fig.6: Induced thermoluminescence (TL) spectra of an undoped ZnO sample at various temperatures. (a) TL intensity distribution displayed by false colors as a function of both wavelength and temperature. Color level is displayed on the right side of the figure. (b) TL spectrum integrated between 150 to 230 ºC. It shows a TL peak around 600 nm. (c) TL glow curve integrated between 550 to 640 nm. It shows a TL peak around 180 ºC [Srivastava *et al*. 2009]

Fig. (a)

(b)

(c)

Fig.7:(a)A naturally occurring ruby crystal (b)Blue sapphire (c)Pink sapphire [Wikepedia]

Graphene based nanomaterials

Graphene is a monolayer of carbon atoms packed into a dense honeycomb crystal structure [Xu *et al.* 2008] or in other words Graphene is the name given to individual sheets of sp^2-hybridized carbon bound in two dimensions of which crystalline graphite, the most thermodynamically stable form of carbon, is composed [Gilje *et al.* 2007]. Even though several other forms of sp^2 carbon including buckminsterfullerene (C_{60}) and carbon nanotubes have been prepared, isolated and studied during the past two decades, single layer graphene has only recently been examined [Novoselov *et al.* 2007]. Over the past two years a great deal of attention has been generated by graphene due to its unique electrical properties stemming from its semimetallic nature, which has produced properties such as quantum Hall effect [Gusynin *et al.* 2005, Zhang *et al.* 2005, Nonoselov *et al.* 2006, Nonoselov *et al*. 2007], ambipolar electric field effect [Nonoselov *et al.* 2004], and transport via relativistic Dirac fermions [Nonoselov *et al.* 2005, Zhou *et al.* 2006]. More recently there have been attempts to observe the theoretical phenomenon known as Klein paradox [Katsnelson *et al.* 2006]. Because of its unique nanostructure and extraordinary properties, graphene has attracted tremendous attention from both the experimental and theoretical scientific communities in recent years and became attractive as potential nanoscale building block for new materials [Li *et al*. 2008].

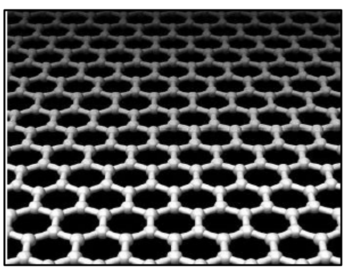

Fig.8:
Honeycomb crystal lattice of Graphene [Xu *et al.* 2008]

The remarkable properties of graphene reported so far include high values of its fracture strength (125 GPa) [Lee *et al.* 2008], Young's modulus (~ 1,100 GPa) [Lee *et al.* 2008], mobility of charge carriers (200,000 $cm^2\ V^{-1}\ s^{-1}$) [Bolotin *et al.* 2008], thermal conductivity (~5000 $W\ m^{-1}K^{-1}$) [Balandin *et al.* 2008], specific surface area (calculated value, 2630 $m^2\ g^{-1}$) [Stoller *et al.* 2008]. These high values make graphene very strong and rigid. These intrinsic properties could lead to the possibility of utilizing graphene for NEMS applications such as pressure sensors. Graphene and chemically modified graphene (CMG) are promising candidates as components in applications such as energy storage materials [Dikin *et al.* 2007], paper-like materials [Park *et al.* 2008, Stankovich *et al.* 2006], polymer composites [Ramanathan *et al.* 2008, Stankovich *et al.* 2006], liquid crystal devices [Blake *et al.* 2008] and mechanical resonators [Bunch *et al*. 2007].

Graphene has been prepared by four different methods. The first was chemical vapour deposition (CVD) and epitaxial growth, such as the decomposition of ethylene on nickel surfaces [Eizenberg *et al.* 1970]. These early efforts (which started in 1970) were followed by a large body of work by the surface science community on 'monolayer graphite' [Aizawa *et al.* 1990]. The second was the micromechanical exfoliation of graphite [Novoselov *et al.* 2004]. This approach, which is also known as the 'Scotch tape' or peel-off method, followed on from earlier work on micromechanical exfoliation from patterned graphite [Lu *et al.* 1999]. Micromechanical exfoliation has yielded small samples of graphene those are useful for fundamental study. This method can repeatedly produce single graphene sheets of up to 10 μm in planer size. The first attempt to produce individual graphene sheets by exfoliation dates to the work of Brodie in 1859 [Brodie *et al.* 1859]. Since then, and despite many attempts [Staudenmaier *et al*. 1898], large-scale production of single graphene sheets has not been achieved. Although large area graphene films (up to ~1 cm^2) of single- to few-layer graphene have been generated by CVD growth on metal substrates [Kim *et al.* 2009, Sutter *et al*. 2008, Reina *et al.* 2009], and graphene type carbon materials have been produced by substrate-free CVD [Dato *et al*. 2008], radio frequency plasma-enhanced CVD [Wang *et al*. 2004], aerosol pyrolysis [Delgado *et al*. 2008] and solvothermal synthesis [Choucair *et al*. 2009, Park *et al.* 2009], the uniform growth of single-layer graphene is still a challenge.

Recently, it is shown that under suitable conditions graphite oxide can undergo complete exfoliation in water, yielding colloidal suspensions of almost entirely individual graphene oxide sheets with a mean lateral dimension of approximately 1 µm. Such sheets can be chemically functionalized, dispersed in polymer matrices, and deoxygenated to yield novel composites [Stankovich *et al*. 2007]. By oxidising and chemically processing graphene, and then floating them in water, the graphene flakes form a single sheet and bond very powerfully. These sheets have a measured tensile modulus of 32 GPa. Soluble fragments of graphene can be prepared in the laboratory through chemical modification of graphite. First, microcrystalline graphite is treated with a strongly acidic mixture of sulphuric acid and nitric acid. A series of steps involving oxidation and exfoliation result in small graphene plates with carboxyl groups at their edges.

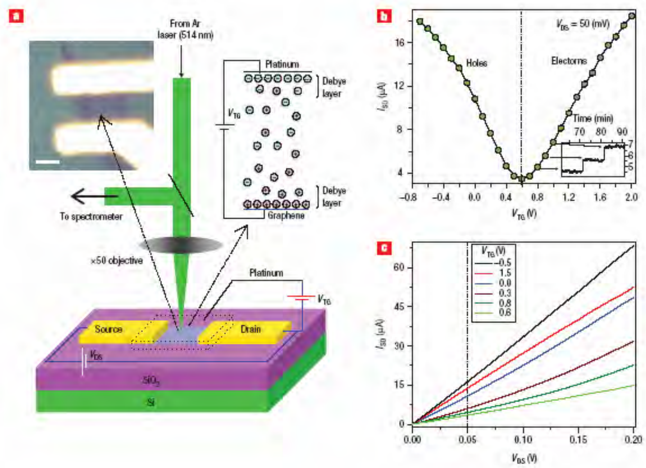

Fig. 9: Electrochemically top-gated grapheme transistor. (a) Schematic diagram of experimental setup. The black dotted box between the drain and source indicates the thin layer of polymer electrolyte (PEO + $LiClO_4$), and the blue stripe between the electrodes represents the grapheme sample. The left inset shows the optical image of a single-layer grapheme connected between source and drain gold electrodes. Scale bar: 5 µm. The right inset is a schematic illustration of polymer electrolyte top gating, with Li^+ (magenta) and ClO_4^- (cyan) ions and the Debye layers near each electrode. (b) l_{SO} as a function of top-gate voltages (V_{TG}). The inset shows the l_{SO} time dependence at fixed V_{TG}. The dotted line corresponds to the Dirac point (change neutrally point). (c) l_{SO} versus V_{DS} at different top-gate voltages [Das *et al*. Nature Nanotechnology 2008].

Bio-nano-technology

It is implicit that nanotechnology is the study of the controlling of matter on an atomic and molecular scale, which deals with structures of the size 100 nanometers or smaller in at least one dimension, and involves developing materials or devices within that size. Bio-nanotechnology draws attention on the development of knowledge and methods through biotechnology that are intimately tangled and needy on various materials – organic and inorganic, routes for synthesis, testing, characterization, properties and devices for applications. Nanostructured materials have received enhanced applications in the science and technology of biological related life-sciences applications. Among these the oxide-based nanostructures like TiO_2 and ZnO exhibit good biocompatibility and high mechanical performance and stability. As an illustrative example, titania (TiO_2) is a material that is non-toxic and non-absorbable by the human body. When deposited via the thermal spray process with proper operating conditions to induce a nanostructured surface, it yields coatings having superior mechanical properties when compared to current hydroxyapatite (HA) thermal spray coatings and excellent biocompatibility as proven by osteoblast cell growth. Because of the nanoparticles embedded in their structures, the resulting TiO_2 coatings are seen as a new generation of coatings for enhancing the performance of implanted biomedical devices. The ZnO, in the field of sensors encompasses a wide variety of materials and devices used for capturing physical, chemical or biological stimuli converting them to measurable output signals. These materials may be used as active sensing elements or receptors, as transducing components (e.g. electro- or chemo-mechanical actuators), and even as electrodes in electronic circuitry and power systems.

Nano-scaled bio applications reveal great dependence in future research in the field of DNA. It is a wonderful material for construction on the nanometre-scale, as molecular glue and as structural material to build nanostructures in both two- and three-dimensions. DNA can also serve as the fuel for artificial molecular motors.

The key to the usefulness of DNA is its ability to store information: the interactions that hold a nanostructure together or drive a device are encoded in the base sequences of the component strands. There is a tremendous effort involved in the design and characterization of DNA tetrahedra, which can serve as rigid building blocks and as molecular cages; the development of DNA motors and fuels; and the application of DNA lattices to protein structure determination.

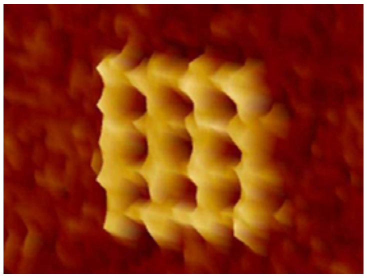

Fig. 10:
A close-up of a DNA "waffle" nanostructure that could function as a logic circuit in a computer chip (Chris Dwyer of Duke University)

Structural capabilities and applications

For the past decade, the chemical and physical properties of fullerenes have been a hot topic in the field of research and development, and are likely to continue to be for a long time. In April 2003, fullerenes were under study for potential medicinal use: binding specific antibiotics to the structure of resistant bacteria and even target certain types of cancer cells such as melanoma. The October 2005 issue of Chemistry and Biology contains an article describing the use of fullerenes as light-activated antimicrobial agents. In the field of nanotechnology, heat resistance and superconductivity are among the properties attracting intense research.

Nanomaterials have the structural features in between those of atoms and the bulk materials. While most microstructured materials have similar properties to the corresponding bulk materials, the properties of materials with nanometer dimensions are significantly different from those of atoms and bulk materials. This is mainly due to the nanometer size of the materials which render them: (i) large fraction of surface atoms; (ii) high surface energy; (iii) spatial confinement; (iv) reduced imperfections, which do not exist in the corresponding bulk materials.

Due to their small dimensions, nanomaterials have extremely large surface area to volume ratio, which makes a large fraction of atoms of the materials to be at the surface or interfacial atoms, resulting in more “surface” dependent material properties. Especially when the sizes of nanomaterials are comparable to Debye length, the entire material will be affected by the surface properties of nanomaterials. This in turn may enhance or modify the properties of the bulk materials. For example, metallic nanoparticles can be used as very active catalysts. Chemical sensors from nanoparticles and nanowires enhanced the sensitivity and sensor selectivity. The nanometer feature sizes of nanomaterials also have spatial confinement effect on the materials, which bring the quantum effects. Nanoparticles can be viewed as a zero dimension quantum dot while various nanowires and nanotubes can be viewed as quantum wires. The quantum confinement of nanomaterials has profound effects on the properties of nanomaterials. The energy band structure and charge carrier density in the materials can be modified quite differently from their bulk counter-part and in turn will modify the electronic and optical properties of the materials. For example, lasers and light emitting diodes (LED) from both of the quantum dots and quantum wires are very promising in the future optoelectronics. High density information storage using quantum dot devices is also a fast developing area. Reduced imperfections are also an important factor in determination of the properties of the nanomaterials. Nanostructures and nanomaterials favor a self-purification process in which the impurities and intrinsic material defects will move to near the surface upon thermal annealing. This increased materials perfection affects the properties of nanomaterials. For example, the chemical stability for certain nanomaterials may be enhanced, the mechanical properties of nanomaterials will be better than the bulk materials. The superior mechanical properties of carbon nanotubes are well known.

Nano materials exhibit superior effectiveness in critical abrasive and polishing applications when properly dispersed. The ultra-fine particle size and distribution of properly dispersed products is virtually unmatched by any other commercially-available abrasives. The result is a significant reduction in the size of surface defects as compared to conventional abrasive materials. Nano materials possess enhanced catalytic abilities due to their highly stressed surface atoms which are very reactive. They facilitate the creation of superior cosmetic products. Nano products provide high UV attenuation without the use of chemicals, provide transparency to visible light when desired, and can be evenly dispersed into a wide range of cosmetics vehicles to provide non-caking cosmetic products. Nano products can provide new and unique electrical and conduction properties for use in existing and future technologies. Nano products can provide new and unique magnetic properties for use in existing and future technologies. They facilitate the creation of superior pigments and coatings. Nano products can also provide more vivid colors that will resist deterioration and fading over time. Nano products can be used in the production of ceramic parts. The ultra-fine size of the particles allows near-net shaping of ceramic parts [Gleiter et al 2000] via super plastic deformation which can reduce production costs by reducing the need for costly post-forming machining.

In summary, it is worth mentioning that the field of nanoscience and nanotechnology is still in infancy and needs further a great fundamental research leading towards applications. Although the existing techniques of materials synthesis and tools for characterization and properties evaluation assist in the initial research but their modifications are very much required for dealing with precise control over properties at nanoscale. The illustrations and examples elucidated in the present chapter bring only a feel about such vast and important field of modern nano-scale research.

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Raw Material Scenario for Indian Steel Industry – Some Key Issues

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I Introduction

Indian Steel Industry has ambitious growth plans. A review of the raw material scenario indicates that there are several constraints in the availability of key raw materials like Iron Ore and Coking Coal. There is an urgent need to take some policy decisions which aim at addressing the key issues.

The paper reviews some of such key issues which are coming in the way of envisaged growth plans of the Indian Steel Industries.

II Iron Ore Issues

Although India has abundant reserves of iron Ore resources, the iron ore is not available to domestic consumers at competitive prices.

India has emerged as one of the largest exporter of iron ore and importer of steel. It is quite a paradox that while India is exporting iron ore and on the other hand, due to supply constraints, we are importing steel from countries like CIS and China.

Out of total production of about 200 Million Tonnes of iron ore, India is exporting nearly 100 Million Tonnes. The iron ore exported is mainly in terms of fines, while lump iron ore is consumed domestically. The domestic prices of iron ore fines are mostly linked to Chinese buying.

China has its coking coal resources which provide them the competitive edge where as India needs to import coking coal.

Competitives of Indian Steel producers comes from domestic iron ore. This makes availability of domestic iron ore at competitive prices critical for Indian Steel Producers. Price differential between Iron-ore fines and lumps has domestically not encouraged value addition of iron ore fines.

Today Indian steel production is at a level of around 60 Million Tonnes per annum. At this level iron ore availability is not a constraint. Domestic supply of iron ore is able to meet demand but as production of steel grows to 125 Million Tonnes and to 200 Million Tonnes, the iron ore availability will become a key concern.

100 Million Tonnes of iron ore fines which are getting exported at present can easily be converted to 60 Million Tonnes of steel without any additional mining to be done.

Government has introduced export tax to discourage export of iron ore. Introduction of various investment allowances for setting up of iron ore sinter plant and pellet plant in India is another tool to discourage export of iron ore fines.

III Coking Coal Issues

Coking Coal and Iron ore constitute larger proportion of steel making cost. India has very small resources of coking coal and most of steel companies are importing their entire requirement of coking coal.

Coal prices have become very volatile which are largely sensitive to Chinese demand. China is a major importer of coal. It has imported arounf 35 MT of coking coal from Australia out of a total export of 125 Million Tonnes from Australia in 2009.

While, Australia has China, Japan, Europe and India as major coal markets. India has only Australia as destination to meet its coking coal requirement.

India should import coking coal from diverse location like Mozambique, Indonesia and even from Canada and USA to reduce reliance on Australia on coking coal front.

The other alternative is to encourage introduction of stamp changing technology to reduce requirement of prime hard coking coal.

We should also encourage introduction of alternative iron making technologies which do not use coking coal.

India has become the largest producer of DRI in the world today. DRI uses domestically available iron ore and coal. It is observed that coal sources are given to power sector on priority basis due to which steel sector is losing its competitiveness.

Indian steel industry needs to be given priority in coal blocks and coal linkage allocated at par with the power sector.

Chrome Ore Reserve Issues

Reserves of chrome ore are fast depleting. Major quantity of chrome ore is being exported to China and Japan.

It is time that we ban the export of chrome ore and make it available to domestic Indian steel producers for increased production of value added steel within the country.

Government must ensure development of chrome ore mines may be through PPP arrangement so as to ensure better availability of chrome ore for indigenous use by domestic steel producers.

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National & International News

National News

TATA Steel eying 21 million tonnes capacity in India

Leading steel maker TATA Steel's domestic manufacturing capacity will jump three folds to 21 million tonne per annum following the expansion of its Jamshedpur project and Orissa and Chattisgarh Greenfield units becoming operational. The present manufacturing capacity of TATA Steel stands at 7 million tonnes per annum. Mr Ratan Tata chairman of TATA Steel at the annual general meeting said that "After completion of the three million tonne expansion project at Jamshedpur, the company's steel manufacturing capacity in Indian operations will enhance to 10 million tonnes per annum by 2012." The company is also setting up a 6 million tonnes per annum Greenfield steel plant at Kalinganagar in Orissa and 5 million tonnes per annum Greenfield integrated steel plant at Bastar in Chhattisgarh. Mr Tata said that "We are in the process of placing orders for equipment for our 6 million tonnes Greenfield steel plant in Orissa, which is expected to be on ground in 3 to 4 years."

Source: Steelguru

SAIL heading towards becoming global company - Mr Verma

Maharatna PSU Steel Authority of India Limited is heading towards becoming a global company for its quality control, pricing, cost efficiency and cost effectiveness. According to Mr C S Verma, chairman SAIL, SAIL would reach its production target of 24 million tonne from existing 14 million tonne by 2012-13. He said that SAIL's modernization program in all its units including Rourkela Steel Plant was under progress. The SAIL chairman in his maiden visit to the steel plant here has expressed his satisfaction over the ongoing modernization plans with a target expenditure of INR 11,800 crore which will be completed by 2012-13.

Mr Verma said the RSP had been contributing 16% of the steel major's overall production while the steel plant's profit margin has registered 19% which proved the efficiency of RSP in the country. SAIL has fixed a target of 60 million tonne by 2020 to meet the country's steel demand which would be estimated to be 180 million tonne.

Mr Verma has lauded the output of Rourkela unit stating that each one of us can take great pride of being part of the SAIL.

Nuclear fuel situation has improved in India - Dr Banerjee

According to Dr Srikumar Banerjee chairman of Atomic Energy Commission, availability of fuel for India's nuclear power plants has improved. The plants that are running on imported fuel (Tarapore) are operating at over 90% capacity. Plants that use domestic fuel are operating at 70% load factor. Availability of domestically produced uranium will improve, now that several mines are being opened, he said. At Tummalapalle project in Andhra Pradesh, work on opening a new mine has been going on. Dr Banerjee expects the mine to start producing sometime this financial year.Dr Banerjee said that the original estimate of Tummalapalle reserves was 15,000 tonnes, but revised estimates show that the mine can hold 45,000 tonnes of uranium. The official estimate of India's uranium reserves is 140,296 tonnes. Against this, the country produces 400 tonnes a year, from six mines in Jharkhand. However, production will increase in the coming years as new mines are being opened. Lambapur and Nalgonda in Andhra Pradesh and Hubli in Karnataka are other places where uranium is found, apart from Meghalaya, where mining is facing stiff opposition. Dr Banerjee said that "The Indian nuclear authorities are discussing with the Russians on the next two projects of 1,000 MW each at Kudankulam. In all, six units of identical capacity are to come up there. The 500 MW prototype fast breeder reactor at Kalpakkam would be generation ready by 2012. Two more fast breeder reactors of 500 MW each would come up at the Kalpakkam site."

Source: Steelguru

NALCO Q1 net profit up by 125pct

National Aluminium Company Limited has come out with impressive results in the Q1 ended June 30th 2010. The net profit has jumped by 125% to INR 284 crore from INR 127 crore achieved in the corresponding period of previous year. According to the results taken on record at a meeting of the Board of Directors in New Delhi today, the company has reported a Sales turnover of INR 1,388 crore an increase of 43% compared to INR 970 crore achieved in the corresponding quarter of the previous year. It may be mentioned that the rise in sales and Profit are attributed to enhanced production volume & sales, improved consumption norms of input materials and better sales realization. On production front too, NALCO has put up an impressive performance. Bauxite production during this quarter increased to 1,067,429 tonnes against 840,328 tonnes in the corresponding quarter. Similarly, Aluminium production increased to 111,663 tonnes from 104,767 tonnes and Power generation to 1659 MU from 1600 MU.

On the sales front also, NALCO sold 108,620 tonnes of aluminium in the Q1 which was 93,104 tonnes in the corresponding period of previous year. Domestic sale of Aluminium also increased by 28% to 83,449 tonnes from 65,112 tonnes in the corresponding quarter.

Source: Steelguru

International News

China's major steelmakers raise Sept. order prices

Baosteel Group Corporation, Angang Steel Company and Wuhan Iron and Steel Corporation released their September order prices on Aug. 16, all of which rose according to market expectations. The prices of all varieties of Baosteel products directly or indirectly increased by 150 to 800 yuan per ton. Prices of Angang Steel's major products have risen by 200 to 1,000 yuan per ton. Wuhan Iron and Steel increased prices of its major plate products 200 to 800 yuan per ton. These increases signify a pessimistic attitude toward the future of the steel market. Compared with the other two steel factories, the price adjustments at Baosteel are relatively moderate. The market has expected the September order prices of steel to rise. Before this price adjustment, there were market rumors that the order situation of Baosteel was not optimistic, which is probably the reason why its price adjustment was not so severe. This round of steel price increases began on July 19. By Sept. 16, the Shanghai market price of 5.5 millimeter hot-roll coils is expected to reach 4,250 yuan per ton, an increase of 420 yuan per ton compared with the former low point. Along with the price adjustments of steel, the price of raw materials also rose rapidly. The spot price of iron ore imported from India on Aug. 16 was 150 to 153 U.S. dollars per ton, a cumulative increase of 19 percent. The increases in the cost of ore overtook the future price of steel, which will reduce steel mills' profits despite the price rise. However, this will add production cost support to the rising trend in future steel prices. Hu Yanping, an analyst from the Umetal Research Center, believes that the current overall supply side of China's steel market is modest. The stock pressure of plate steel is rather large while that of the screw-thread steel and wire rod is small. In addition, the peak season is coming, so the future steel price is still expected to rise.

Source: People's Daily Online

Wuhan Steel in talks with ArcelorMittal

China's third largest steel mill Wuhan Iron & Steel Group is in talks with ArcelorMittal, the world's largest steelmaker to jointly develop overseas mining projects to gain more raw material resources and reduce cost risks. Peter Kukielski, head of ArcelorMittal's mining sector, visited Wuhan Steel last Thursday. ArcelorMittal is willing to work with Wuhan Steel on iron ore projects via joint development and investment, Wuhan Steel said on Monday. Wuhan Steel spokesman Bai Fang said the two sides are still in the discussion stage and nothing has materialized yet.

ArcelorMittal has 26 iron ore mines with an annual production capacity of 51 million tons and aims to expand to 100 million tons by 2015, the statement said. The company is looking at plans in countries including Liberia, Senegal and Mauritania, Kukielski said in March. "Although ArcelorMittal is self-sufficient with iron ore now, they still aim to gain new iron ore resources working with Chinese steelmakers will help them to reduce risks," said Hu Kai, an analyst with consulting firm Umetals.com.

"If European economy changes and cannot digest the expansion of iron ore supplies, ArcelorMittal can transfer it to China to manage risks." "It's a win-win situation. If Wuhan Steel is bidding for an iron ore project with competitors, the price will definitely be driven up. The joint development will help reduce cost risks for both sides," said analyst Xu Xiangchun from Mysteel.com. Wuhan Steel is a good potential partner as it has accumulated experience after years of going overseas, he said. Wuhan Steel has been seeking to invest in more overseas iron ore assets to cut its reliance on expensive imports. "We aim to be self-sufficient in iron ore supplies in three to five years," Deng Qilin, chairman of Wuhan Steel, said in March. Wuhan Steel in May received approval from the National Development and Reform Commission for two overseas acquisitions in Africa that are expected to contribute nearly 2 billion tons of iron ore deposits.

Last October, Wuhan Steel agreed to buy more than 40 million tons of iron ore under a seven-year contract with the Venezuelan company at a "China Price" separate from what the big three global miners are charging. Wuhan Steel also acquired a 21.52 percent stake in Brazilian iron ore miner MMX Mineracao e Metalicos SA for $400 million last year. The company also received approval from the Australian government for a A$271 million ($249 million) investment in Centrex Metals Ltd in November, and also for a 60-percent stake in the iron ore rights to five Centrex projects in South Australia.

Source: People's Daily Online

ArcelorMittal plans to build steel factories in Indonesia

World largest steel producer ArcelorMittal would invest in the steel industry in Indonesia from down to up stream sectors with investment of more than 5 billion U.S. dollars, Indonesian industrial ministry said here. The company planned to build two factories in Banten province near Jakarta and Pasuruan town of East Java province, Director General for Metal, Engine and Textile Industries of the ministry Ansari Bukhari said. "I think Mittal would not invest in steel making only otherwise it would make its industrial structure weak. The investment must be integrated," he was quoted by detik online as saying Wednesday. Two representatives of Mittal visited the ministry on Tuesday afternoon and met with the ministry's officials to talk about the plan. During the meeting, the representatives delivered the plan to invest in steel sector in Indonesia and asked about the incentives for it, Director of Metal Industry of Industrial Ministry I.G. Putu Suryawirawan told the online in Tuesday evening. "Basically, the government supports on the plan," he said. The director reaffirmed that at its visit here in April Mittal committed to invest 5 billion U.S. dollars in the sector, said Suryawirawan. Indonesia has attempted to boost its steel production from 2.5 million tons to at least 7 million tons a year to meet growing domestic demand. Lacks of funds and technology have hampered the country to step up its production by it self. The biggest Southeast Asia economy imports 6 million tones of steel per year to meet the demand, according to the country's investment board.

Source: People's Daily Online

Outdated iron and steel companies given two months to improve

China's industry chiefs have warned more than 2000 companies to close obsolete production facilities within two months or face cuts in credit and a suspension of government approvals. The official *Xinhua* news agency reported that The Ministry of Industry (MIIT) and Information Technology has set the deadline at the end of September for firms to shut down outdated facilities in a move to cut overcapacity and raise the level of economic growth. The government order involves 2087 companies and covers 18 industries: iron, steel, coke, iron alloys, calcium carbide, electrolytic aluminium, copper smelting, lead smelting, zinc smelting, cement, paper-making, glass, ethanol, monosodium glutamate, citric acid, leather-making, printing and dying, and chemical fibres. The iron, cement and sectors had the most numbers of companies ordered to close outdated energy-consuming and polluting capacities. Liuzhou Iron and Steel Co, according to the government decree, would need to slash 2Mt of outdated iron-making capacity. Companies that failed to do so before the deadline would have their waste discharge licenses revoked, said Li Yizhong, Minister of Industry and Information Technology. Bank loans and new project approvals from the government would not be provided to those companies who failed to clean up, said Li. The failing companies would not get approval from land management authorities to apply for more new land for their projects while production licenses would also be recalled by relative authorities, said Li. Companies could face possible power cuts from suppliers if they failed the mission, said Li Yizhong. "Outdated capacities consume energies heavily, pollute the environment, and are safety risks. They reflect the very crude and quantitative mode of economic growth," said Li. "They are also the causes of the low quality, inefficiency, and weak competitiveness of our national economic development," he said. The government has set a target to improve energy efficiency by 20% by the end of 2010, compared to the level five years ago.

Source: Steel Times International

PetroChina Unit Kunlun Energy profit jumps fourfold

Bloomberg reported that Kunlun Energy Co the oil producer and gas supplier controlled by PetroChina Co increased first half profit almost fourfold as crude prices rebounded and sales of natural gas rose. The company formerly known as CNPC Hong Kong Ltd said net income climbed to HKD 1.25 billion or 24.8 Hong Kong cents a share from HKD 316.3 million or 7 Hong Kong cents a year earlier. According to the statement Kunlun, operator of nine oilfields in China, Kazakhstan, Thailand, Peru, Oman, Indonesia and Azerbaijan reported an 86% jump in first half revenue to HKD 3.7 billion as crude oil surged 52% in New York during the period. Sales of gas climbed 53%.Kunlun said about 60% of first-half sales came from oil production and 40% from gas distribution in China. The company said it expects gas to be its main revenue source by 2012. Kunlun said in January it may spend as much as HKD 10 billion on gas projects this year. China wants to triple gas use to about 10% of its energy consumption by 2020 to reduce its reliance on coal which produces more emissions.

Source: Steelguru

Vedanta deal not against India interest - Cairn Energy

PTI reported that seeking to placate the Oil Ministry's concerns on its deal with Vedanta Resources; the UK's Cairn Energy said that it will comply with all contractual obligations in sale of its majority stake in Cairn India to the world's fifth largest miner.With signs of discomfort at a non oil firm taking control of a company whose main property is the Barmer district oilfields in Rajasthan, Cairn Energy said that Vedanta has promised to keep Cairn India independent and meet all obligations. Mr Bill Gammell CEO of Cairn Energy wrote to Mr S Sundareshan oil secretary saying that Vedanta, besides having a successful experience in executing and operating complex large scale industrial projects has a culture of empowering management as evident in its previous acquisitions.

Source: Steelguru

Chongqing Steel to commission first phase of relocated facilities next June

According to a statement from Chinese steelmaker Chongqing Iron and Steel on August 24th, the first phase of its new relocated facilities in Changshou, Chongqing with an annual capacity of 6.5 million tonnes will put into production in June 2011 with Chongqing Iron and Steel expecting to become the largest shipbuilding steel production base in China by then.Mr Dong Lin chairman Chongqing Iron and Steel said the company output of shipbuilding plate was 1 million tonnes ranking eleventh in the domestic steel industry while in 2009 its output of this product only dropped six percent while overall production of shipbuilding plate in China declined by 24% with its shipbuilding plate output ranking fifth in the domestic industry.As regards 2010, since the successful run of its first production line in its relocated facilities, the company's annual shipbuilding plate output is expected to rank among the first three in China.In recent years, Chongqing Iron and Steel shipbuilding bulb steel made to European standards has received certificates from seven national classification societies meanwhile, the steelmaker share in China domestic market for this product has reached 60%.

Source: Steelguru