

IPF PLASTICS INDIA

AN OFFICIAL ORGAN OF INDIAN PLASTICS FEDERATION
Log on to our Website : www.plasticfederation.org



IndianOil

Petrochemicals...

holding the key to moulding tomorrow

For Polymer Products : PP, HDPE, LLDPE manufactured by
Indian Oil Corporation Limited

Please Contact: Del Credere Associate cum Consignment Stockist

UMA PLASTICS LIMITED

An ISO 9001:2008 & ISO 14001:2004 Certified Company

Regd. Office : 14 B, Camac Street. Kolkata - 700017. India

Phone : +91-33-22810775 / 6967. Fax : +91-33-22813961

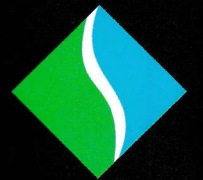
Mobile: +91-9830142233. Email: polymers@umagroup.in



Exclusive Range of Plastic Moulded Furniture for Exclusive Lifestyle

Visit us at : www.umaplastics.com & www.swagathfurniture.com

SHRACHI RENU POLYMER



SHRACHI



Products Details

Colour Master Batch • White Master Batch
Calcium / Talc Filled PE Compounds
Additive Master Batch • Any Other Plastic Compounds

User Industries

Woven Sacks (Raffia) • Films / Tarpaulines • Water Tanks
Non Woven Fabrics • Plastic Carry Bags

Aiming and Delivering the Best Always

Contact Details

2, Jessore Road, Dum Dum Road, Kolkata-700 028, India
Tel : 2550 2487, Mob : 91633 63829, Fax : 91(33)2547 2044
E-mail : saket.tibrewal@hotmail.com



PLASTICS INDIA

A journal for the growth and development of plastics trade & industry

President
Sourabh Khemani

Vice President
Rajesh Mohta

Hony. Secretary
R A Poddar

Hony. Joint Secretary
Ramesh Rateria

Hony. Treasurer
Ashok Jajodia

Editor
Sri Pradip Nayyar

Editorial Board
K. K. Seksaria
R. M. Maheshwari
D. K. Chatterjee
Shyamlal Agarwal
Dr. S. K. Verma
Jayanta Goenka
Pawan Kr. Newar

Printed and published by Sri Ramawatar Poddar on behalf of Indian Plastics Federation and printed at **CDC Printers (P) Ltd.**, Plot No. 5,6,16 &17, Tangra Industrial Estate - II, 45, Radha Nath Chowdhury Road, Kolkata - 700015, Phone : 2329 8856-57, Fax : 2329 8858, E-mail : cdc@cdcprinters.com and published at :

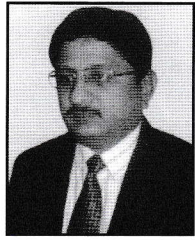
INDIAN PLASTICS FEDERATION

8B, Royd Street, 1st Floor
Kolkata - 700 016 (INDIA),
Phone: 2217 5699 / 5700 / 6004
Telefax : 91-33-2217 6005
Email : ipf@cal2.vsnl.net.in,
Web : www.plasticfederation.org

Editor : Sri Pradip Nayyar

- The opinions expressed by the authors do not necessarily reflect or are in agreement with the views of the Federation.
- The Federation does not accept responsibility for the correctness of news, commercial intelligence and statistics given, although every care has been taken to verify them from authentic sources. Users of same should, in their own interest, consult legal authorities and financial channels before dealing any transaction.
- All rights reserved. Reproduction without the permission of the Editor is prohibited.

Editorial



Worldwide, the micro small and medium enterprises (MSMEs) have been accepted as the engine of economic growth and for promoting equitable development. The major advantage of the sector is its employment potential at low capital cost. The labour intensity of the MSME sector is much higher than that of the large enterprises. The MSMEs constitute over 90% of total enterprises in most of the economies and are credited with generating the highest rates of employment growth and account for a major share of industrial production and exports. In India too, the MSMEs play a pivotal role in the overall industrial economy of the country. In recent years the MSME sector has consistently registered higher growth rate compared to the overall industrial sector. With its agility and dynamism, the sector has shown admirable innovativeness and adaptability to survive the recent economic downturn and recession.

As per available statistics (4th Census of MSME Sector), this sector employs an estimated 59.7 million persons spread over 26.1 million enterprises. It is estimated that in terms of value, MSME sector accounts for about 45% of the manufacturing output and around 40% of the total export of the country.

Small Scale Industries may sound small but actually plays a very important part in the overall growth of an economy. Small Scale Industries can be characterized by the unique feature of labor intensiveness. The total number of people employed in this industry has been calculated to be near about one crore and ninety lakhs in India, the main proponents of Small scale industries.

The importance of this industry increases manifold due to the immense employment generating potential. The countries which are characterized by acute unemployment problem especially put emphasis on the model of Small Scale Industries. It has been observed that India along with the countries in the Indian continent have gone long strides in this field.

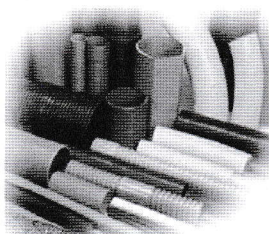
Small Scale Industries are providing large-scale employment next to Agriculture. It has played a vital role in the districts economy by providing large scale employment opportunities at relatively low capital cost, a wide entrepreneurial base, easy dispersal of industries in rural areas and concentration of certain industrial groups at specific areas.

Small Scale Industries may sound small but actually plays a very important part in the overall growth of an economy. Small Scale Industries can be characterized by the unique feature of labor intensiveness. The total number of people employed in this industry has been calculated to be near about one crore and ninety lakhs in India, the main proponents of Small scale industries.

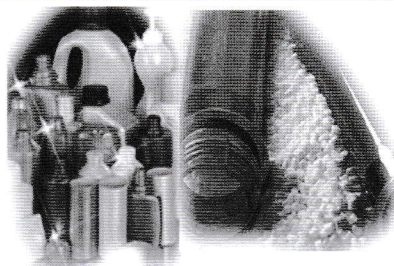
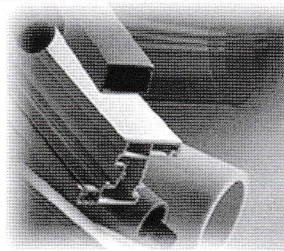
The importance of this industry increases manifold due to the immense employment generating potential. The countries which are characterized by acute unemployment problem especially put emphasis on the model of Small Scale Industries. It has been observed that India along with the countries in the Indian continent have gone long strides in this field.

Pradip Nayyar

Editor

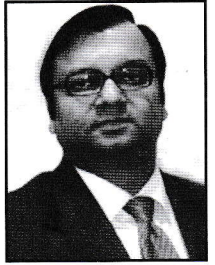


CONTENTS



- 3** Editorial
- 5** Presidential Address
- 6** Visit Report
- 7** Glimpses
- 9** From the Desk of Hony. Secretary
- 11** Application
- 28** News Round Up
- 29** Visit to Chinaplas 2011
- 34** Monthly Circular

PRESIDENTIAL ADDRESS



Dear Members,

The New Government has been formed in West Bengal after 34 years of Left regime.

We as industrialists expect a friendly atmosphere for industrialization and work culture.

In this issue I wish to share some inputs on Polymer based fiber optic technology to make internet much faster....

A new polymer based technology developed for the nano-photonics market by researchers from Tel Aviv can make computers and the Internet hundred times faster. This technology is a communications technology "enabler" that may start being used only five or ten years in the future, currently being created by Dr. Koby Scheuer of Tel Aviv University's School of Electrical Engineering. Dr. Scheuer has developed a new plastic-based technology for the nano-photonics market, which manufactures optical devices and components.

Reported in the journal Optics Express, his plastic-based "filter" is made from nanometer-sized grooves embedded into the plastic. When used in fiber optics cable switches, this new device will make our communication devices smaller, more flexible and more powerful. In the near future, all communication will go through fiber optics cable coming into every home - telephone, cable TV, the Internet. But to avoid bottlenecks of information, the information coming through will need to be separated into different channels. The new polymeric devices can do that in the optical domain at an unimaginable speed, quality and cost. This new technology uses plastic-based switch, replacing hard-to-fabricate and expensive semi-conductors.

Semi-conductors, grown on crystals in sterile labs and processed in special ovens, take days and sometimes months to manufacture and are delicate and inflexible. The new plastic polymer switches come in an easy-to-work-with liquid solution. Using a method called 'stamping' almost any laboratory can make optical devices out of the silicon rubber mold we've developed. The silicon rubber mold is scored with nano-sized grooves, invisible to the eye and each less than a millionth of a meter in width. A plastic solution can be poured over the mold to replicate the optical switch in minutes. When in place in a fiber-optic network, the grooves on the switch modulate light coming in through the cables, and the data is filtered and encoded into usable information.

The biggest hurdle lies in convincing the communications industry that polymers are stable materials. The device can also be used in the gyros of planes, ships and rockets; inserted into cell phones; and made a part of flexible virtual reality gloves so doctors could "operate" on computer networks over large distances.

With warm regards,

A handwritten signature in black ink, appearing to read 'Sourabh Khemani'.

Sourabh Khemani
President

**VISIT REPORT BY SHRI AMAR SETH CHAIRMAN INDPLAS '12 EXHIBITION
ORGANIZING COMMITTEE TO CHINAPLAS 2011 HELD AT GUNGHOU,
CHINA FROM 17TH TO 20TH MAY 2011**

As per our cooperation agreement signed with ADSALES — organisers of China plas'11, IPF was allotted a complimentary 9 sq mtr stall at the exhibition to Propagate Indplas '12. Similar complimentary stall shall also be available to IPF at China plas '12 to be held at Sanghai.

In cooperation with Mrs May of Pilatus—Indplas '12 agent, stall was readied on 16th May.. An English & Chinese speaking hostess was also hired for all four days who not only looked after the visitors at the stall but also distributed Indplas '12 leaflets to exhibitors in various stalls. Large number of visitors mainly from China visited the stall. Visiting cards given to Mrs May for follow up. Visiting cards of visitors from other countries are with IPF now and follow up thanks mails sent.

On 17th May both Mr R A Lohia and Self attended Reception and Inaugural session of China plas as a VIP invitee. At the reception, we could meet heads of various associations from world over.

On 17th May — Self met Mr Wang — President of Taiwan Machinery Mfg Association (TAMI) at their stall along with Pilatus owners — Mr Michel and Mrs May. We discussed the possibility of TAMI extending support to Indplas'12 so that exhibitors from Taiwan get subsidy to participate in Indplas '12. Mr Wang was receptive but mentioned that it is too early to take up this case. However assured of full cooperation.

1. Exhibitor Organizing

CTPIA offer Exhibitors booked by IPF to participate in the 11th China Plastics Exhibition & Conference (China PEC'2011) in Sept, 2011 a discount of 20% either to IPF or direct to Exhibitors as decided by IPF.

2. Visitor Organizing

CTPIA offer.

The delegates from IPF will be their VIP guest and attend China PEC opening ceremony

(a) Free hotel rooms for 3 nights (two share one room), check in time: 2 pm on 21th,Sept, (b) Free breakfast. (c) Free shuttle between hotel and exhibition centre, (d) Free catalogue, (e) Free Factory visits.

On 18th May—Self also met Mr Stanley Chu—Chairman of Adsales and Ms Ada —Asst G M of Adsales for a courtesy call and thanked them for complimentary stall and VIP treatment.

On 18th few of the IPF delegates also met senior officials of ADSALES and exchanged greetings. Self mentioned about IPF KC and Indplas '12.

Recommendation

Participation in 2011 seemed to be too early but surely IPF should participate in Chinaplas 2012 to be held in April '12 which shall be near to Indplas '12.

Amar Seth

Chairman

Indplas '12 Exhibition Organizing Committee

GLIMPSES

INTERACTIVE SESSION WITH MR. P. S. BHATTACHARYYA, M. D. HALDIA PETROCHEMICALS LIMITED

Shri P. S. Bhattacharyya, the New Managing Director of Haldia Petrochemicals Limited visited the Indian Plastics Federation and interacted with the Executive Committee members of IPF on 02/05/2011 at IPF Conference Hall. During the interaction the MD



agreed to our request to use their name and logo in Indplas'12 brochure and other promotional materials as a PLATINUM SPONSOR.

A TECHNICAL LECTURE ON CLARIFIED POLYPROPYLENE APPLICATION

A technical lecture on 'Clarified Polypropylene Applications' was held on 26th May 2011 at IPF Conference Hall. Representatives from HPL and Adeka, Japan made the presentation on the polymers and displayed various applications of the same. The programme was organised jointly by Indian Plastics Federation and Indian Plastics Institute - Kolkata Chapter.



*What is the colour of
Your Success?*

"Colouring Solutions for Plastics"

Product Range

- *AFMB - White & Natural*
- *White Master Batches*
- *Black Master Batches*
- *Colour Master Batches*
- *Special Effect Master Batches*
- *UV Master Batches*
- *Antistatic Master Batches*
- *Additive Master Batches*
- *Metallic Effect Master Batches*
- *Pearl Effect Master Batches*
- *PP Compounds*
- *Nylon Compounds - Filled & Unfilled*

PRABHU POLYCOLOR PVT. LTD.

33A, J. L. Nehru Road, 12th Floor, Suite#7, Kolkata-700 071
Phone : 033-3048 1800 / 1801, Fax : 033-3048 1802
E-mail : pknewar@hotmail.com, Mobile : 98303 01614

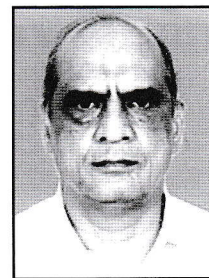
Works : # 13, Ponnamman Nagar, Ayanambakkam, Chennai - 600 095
Ph : 044 - 2653 3929 / 3937, Fax : 044 - 2653 3954
E-mail : prabhupoly@yahoo.co.in, prabhupoly@vsnl.net
Web : www.prabhupolycolor.com

Depots : Multiplast, PUNE (93713 06850)
Lab Supplies, BANGALORE (99001 01756)



From the Desk of

The Hony. Secretary



Dear Members

Elections to the West Bengal State Legislature is complete and a new Government has come to power after a gap of 34 years. We wish the new Government our best wishes for the growth & development of the State.

In our last E. C. meeting it has been decided that IPF jointly with iLEAD will organise a Plastics Entrepreneur Development Programme that will be conducted initially at iLEAD, and later at IPF Knowledge Centre once our Knowledge Centre becomes operational. Shri Sourabh Khemani and Shri Manish G. Bhaia have been nominated by the Executive Committee to the board of iLEAD for advice and coordination.

Members will be pleased to know that a 46 member delegation visited Chinaplas 2011 held at Guangzhou, China from May 17 – 20, 2011. Organisers offered IPF a complimentary stall from where Indplas'12 was promoted. Leaflets of Indplas'12 in Chinese language were distributed during the exhibition. Members will be glad to know that IPF has signed a Barter Deal with China Taizhou Plastics Industry Association, China for promotion of Indplas'12 and their China PEC'2011 to be held in September 2011. The visit was a great success.

A technical lecture on 'Clarified polypropylene applications' was held at IPF Conference Hall on 26th May 2011. The speakers were from Haldia Petrochemicals Ltd. and Adeka, Japan. Various applications of the polymer were displayed to the members.

IPF organised Kolkata Launch Function of PI-12 on 7th June 2011 at Hotel Hindustan International. Shri Ashok Goel, President Plastindia Foundation, Shri R. K. Lohia, Chairman – NEC PI-12 and Shri Jigish Doshi, Chairman – Proplast PI-12 attended the Launch function. The Guest of Honour was Shri Firhad Hakim, Hon'ble Minister of Urban Development & Municipal Affairs. After the formal addresses the PI-12 logo was unveiled and a film on Plastindia Exhibition was shown. A film on A STEP FORWARD was shown after the PI film. Earlier in the day a Press Conference was held at Olympus Lounge in the same hotel. The Launch Function was followed by Cocktail & dinner. Both the Press Conference and Launch function were a great success.

With Best Wishes

A handwritten signature in black ink, appearing to read 'R. Poddar'.

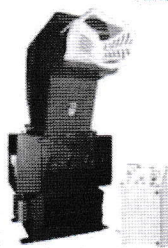
Ramawatar Poddar
Hony. Secretary

PIECO "QUALITY WITH
Since 1983 **INDIGENOUS TECHNOLOGY"**

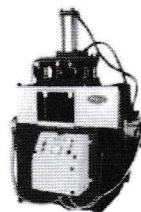
RANGE OF PRODUCTS

- PLASTICS SCRAP GRANULATOR
- DRY BLENDING CONICAL MIXERS
- DRY BLENDING VERTICAL MIXERS
- LUMP CUTTERS
- BLADE SHARPENERS
- AGGLOMERATORS
- MEDIUM SPEED GRANULATOR

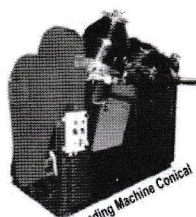
PLASTICS SCRAP GRANULATOR
GRINDING CAPACITY :
10 Kgs./Hr. to 1000 Kgs./Hr.



Scrap Granulator



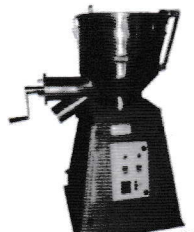
Lump Cutter



Dry Blending Machine Conical



Mini Granulator



Vertical Dry Blending Mixture

Mfg. by
PIECO Pioneer Engineering Corporation

Regd. Office : 218, Veena Dalvai Industrial Estate, Oshiwara, S.V. Road,
Jogeshwari (West), Mumbai - 400 102

Telephone : 022-26787168 / 28473787, Mobile : 9820998657

E-mail : dinesh@piecomachines.com, pieco@aol.in, Website : www.piecomachines.com

Factory : Plot No. A2/2218, G.I.D.C., III Phase, Vapi - 396195 Dist. Bulsar (Gujarat) (INDIA) Tel.: 0260-2431282, 2423895

PIECO THE NAME IN MARK OF QUALITY AND RELIABILITY.



INDIAN PLASTICS INSTITUTE
(Kolkata Chapter) along with
INDIAN PLASTICS FEDERATION



Organises 15th Session of
PLASTICS TECHNICIAN COURSE
Suitable for

MACHINE OPERATOR, SUPERVISOR, TESTING PERSONNEL.

ENTREPRENEURS also welcome to enhance small business and Entrepreneur Skills.

Placement assured for the right candidate.

Faculty includes experts from the Plastics Industry and leading Educational Institutions.

SESSION STARTS FROM JULY 2011

For further details please contact directly to

Mr. S. Mustafi (Mobile : 98315 25026)

Fiber Reinforced Plastics (FRP) is a composite material formed by impregnating reinforcing material like fiber in a matrix or binder material (thermosetting or thermoplastic resins). Materials like fibers or pigments are also present in the composite but they are not essential parts of the composites. When there is an effective bond or adhesion between the matrix and the reinforcement, the optimum properties of composites can be formed. The matrix in a composite performs two major roles – firstly, it transfers load to the reinforcement and secondly, it protects the reinforcement from the environmental effects.

Advanced FRP composites are composites with superior properties. Generally, advanced composites refers to composites with greater than 50% fibers by volume and with a modulus of elasticity of the reinforcement higher than 200,000 MPa. There are two types of polymer matrices used in advanced FRP composites i.e. thermosets and thermoplastics. Both thermosetting and thermoplastic matrices have different intermolecular structures. All thermosetting resins can be reinforced because most of them are liquids and hence, they can be easily mixed with the reinforcement in order to form a moldable compound. An effective bond between the resins and the reinforcement can be formed because thermosetting resins are good adhesives. Thermoplastic materials are modified with the appropriate coupling agents to form an effective bond between the resin and reinforcement. Thermosetting materials are cured to achieve a useful state by heating alone while thermoplastic materials can be cured only by heating. Thermoplastic materials are solids which on heating undergo melting, then forming and after cooling achieve a solid useful form. Hence thermoplastic materials can be recycled whereas thermosetting materials cannot. Thermosetting materials require a longer cycle time than thermoplastics.

High Performance Matrix Resins for Advanced FRP Composites

1) THERMOSETTING MATRICES

Thermosetting resins require curing during the cross-linking process. This process is irreversible and makes these resins infusible. The crosslinked resins give good rigidity, excellent dimensional stability, high thermal and creep resistance. The cured resin cannot be reprocessed. As pure liquid, thermosetting resins have limited use, however, on adding other chemicals they can be made processable. For reinforced plastics, the resin system is used with curing agents, hardeners, inhibitors and plasticizers. In order to give special properties like flame retardancy, UV stability or electrical conductivity, special fillers or additives are used. Examples of thermosetting resins used in advanced FRP composites are epoxies, phenolics, poly benzimidazoles, silicones, bismaleimides, polystyrylpyridines, polyphthalocyanines, polyimides, etc.

1) Epoxies : These contain two or more epoxide groups, or more generally glycedyl group molecule. The uncured epoxies nature range from free-flowing liquid to high melting solids. They are cured with the help of appropriate curing agents. Epoxies offer high strength to weight ratio, good electrical properties, chemical resistance, low shrinkage (1-2%), low moisture absorption, excellent thermal capability, corrosion protection etc. Because of their superior properties, they are reinforced with high performance fiber reinforcements such as carbon fibres and high concentration of glass fibers. The choice of curing system

for epoxies decides the final properties of the cured composites.

There are seven classes of epoxies

- a) Bisphenol – A based
- b) Glycedyl amines
- c) Glycedyl esters
- d) Novolacs
- e) Brominated resins
- f) Cycloaliphatic
- g) Others

Epoxies are cured by three types of curing systems namely amines, anhydrides and catalytic curing. Epoxies have higher viscosities, hence to lower the viscosity and improve their handling characteristics, diluents are added in the concentration range of 2 – 20 %. They improve the cured properties of the resin.

2) Phenolics : These resins are formed by the reaction between phenol and formaldehyde either in the presence of acid or base catalyst. The reaction is condensation type where a water molecule is eliminated as a byproduct. There are two types of phenolics viz. novolac and resole.

Novolacs are crosslinked by the addition of a hardener such as hexamethylenetetramine while resoles require only heat to convert them to the fully crosslinked state.

Phenolic resins have excellent dimensional stability, good electrical properties, fair resistance to acids, and good heat and combustion resistance (up to 200 degree C or 400 degree F). They are also low in cost. However,

they require extreme processing conditions. The physical properties are retained up to 200 degree C (390 degree F). Heat distortion temperature is 250 degree C (480 degree F). These resins show low emission of smoke and toxic fumes on burning, and no release of flammable vapour. The resins have no autopropropagation of flame. The principle applications are for rocket nozzles, nose cones, high temperature air ducts, wings and fins for rockets.

3) Polyimide Resins : They have excellent thermal stability up to 370 degree C. The polymer is formed by the reaction between dianhydride and diamine. Polyamic acid is formed as an intermediate product during the reaction, which being unstable, has to be stored in a polar solvent under dry refrigerated conditions. During this reaction water is eliminated. This complicates the molding process.

The polymer has inherent resistance to combustion, excellent dimensional stability, and tensile and impact strength. However, these resins have higher water absorption property (4-5% by weight), high brittleness and are difficult to process.

To attain full thermal stability, the molding is carried out at 300 degree C with a post cure at about 410 degree C. These resins are used in aircraft engine, electrical components, wire and cable insulation, chip carriers for integrated circuits, etc.

4) Polybenzimidazoles (PBI) : These resins have superior physical and thermal properties. The disadvantages of these resins are that they are toxic, hence should be handled with care. Also, these resins have difficult synthesis procedures

and fabrication methods. They are also expensive.

5) Silicones : These are semi-organic compounds famous for their excellent heat resistance and electrical properties, low water absorption properties and good weatherability over a wide temperature range. These resins are crosslinked with the help of catalysts such as amines, cobalt naphthanate, zinc octate, etc. Rigid silicones have excellent heat resistance up to 500 degree F and are used where flame retardant properties are required. The prepreps are also formed by these resins. These resins are used for transparent coatings and in optical applications.

6) Bismaleimides : These are prepared by the reaction between maleic anhydride and diamine. The characteristics of these resins are similar to epoxies. The temperature resistance capacity of these resins is higher (232 degree C). They require low processing temperature in comparison to other polyimide resins. The curing temperature is around 175 degree C. Standard epoxy process equipments can be used for these resins. Post cure at 477 degree C is a must to attain higher temperature stability. During composite preparation, no volatiles are removed and consolidation is not present. Also tack and drape of these resins are excellent. These are mainly used in composite preparation for military aircraft and aerospace applications.

7) Polystyrylpyridine Resins (PSP) These resins are manufactured by the reaction between methylated derivative of pyridine and aromatic aldehydes. Required press cure temperature is 200 degree C for three

hours. Post cure temperature is about 250 degree C for 3-16 hours. They show very high temperature resistance for long term at 250 degree C, have very low moisture absorption and flammability, and low smoke toxicity. These resins are used in missile applications.

8) Polyphenylquinoxaline Resins : These are acetylene terminated resins. The cure is through a radical initiated addition reaction without evolution of volatiles. The thermal stability is up to 190 degree C. They show very low moisture absorption.

II) THERMOPLASTICS

Thermoplastics are formed by the application of heat and pressure followed by cooling. They do not require reactive cure cycles. The thermoplastic resins that are used in composite preparation can be separated into two categories-

- 1) Traditional industrial thermoplastics : Not used in advanced FRP composites.
- 2) High performance thermoplastics: Used in advanced composites.

High performance Thermoplastics :

Several important thermoplastic materials have been developed for use in advanced composites. These resins show inherent thermal and mechanical properties, and good flammability. They emit less smoke while burning and are self-extinguishing. However, these resins are costly. Some examples of high performance thermoplastic materials are PEEK, PS, LCPs and GMTs. These resins can be reinforced with glass or carbon or other high performance fibres.

- 1) Polyphenylenes (PPE, PPS, PPO): These resins are one of the most

successful groups having medium to high cost and also good performance. They show excellent thermal and dimensional stability, good flame resistance and good electrical properties. These resins are reinforced with short-fiber, and also glass or carbon mat or woven fabrics. They show higher impact strength, are insoluble in most of the solvents at temperature below 200 degree C and show thermal stability up to 260 degree C. Some carbon reinforced grades are used in chemical process industry because of their high resistance to strong oxidizing inorganic acids. They burn with difficulty when exposed to flames, show low smoke emission, are self-extinguishing and do not generate toxic gases on burning. These resins are used in aircraft and automotive industries.

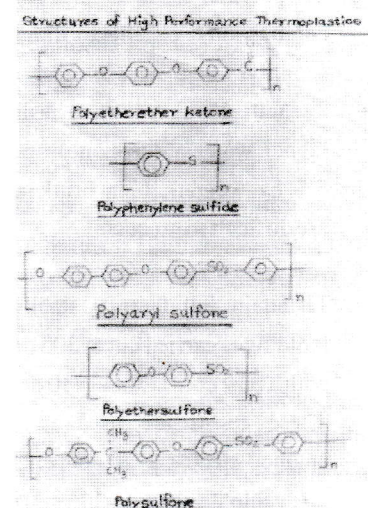
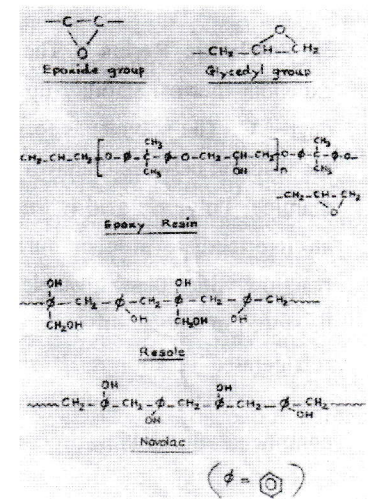
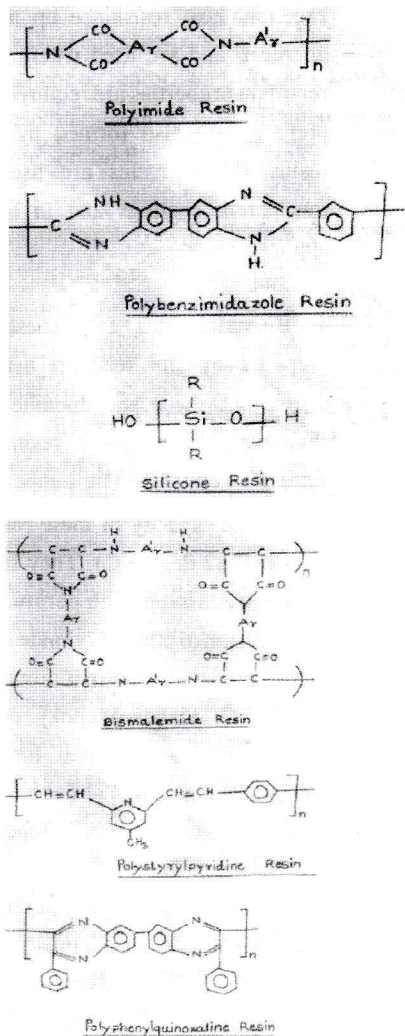
2) Polysulphones : These resins are characterized by their high heat stability and show good oxidative resistance. Example, polyether sulphone, which has continuous service rating of 180 degree C. The resin has self-extinguishing characteristics and burns with low smoke. The reinforced grades are used in aircraft interiors.

3) Polyetherimide : Polyetherimide is an amorphous, transparent polymer. It has amber colour, shows good impact strength, rigidity and excellent heat stability around 250 degree C. It can be reinforced with glass or carbon fibers, and can be drawn into fibers for use as a reinforcing material. This polymer is used in aircraft interiors.

4) Polyketones : It is a crystalline polymer with excellent high temperature resistance up to 240 to

250 degree C for continuous use. These resins are self extinguishing and hence show low smoke emissions on burning. They have good chemical resistance, hydrolytic stability and mechanical properties. They show good elongation, good toughness and impact resistance, high modulus and creep. The drawbacks include higher cost and brittleness at lower temperature. These resins are used in aircraft industries.

5) Glass Mat Thermoplastics : These are a new class of materials similar to thermosetting resin SMC. There are several ways to produce GMT materials. To obtain better flow properties, sheets are reinforced with needled mats. Thermoplastic powdered material, glass fibers and foaming agents are used first to produce a thick foam. This foam is spread on the porous belt and the foam is collapsed by applying suction. The wet sheet produced is the GMT material.



Source : Polymer Society

Trends and Frontiers in Graphene-Based Polymer Nanocomposites

Prithu Mukhopadhyay*

and Rakesh K. Gupta**

*IPEX Technologies Inc.,

Verdun, Quebec, Canada

**West Virginia University,

Morgantown, West Virginia,

USA

Polymers have been combined with other plastics to form blends, mixed with talc and clay to give filled systems, and extruded and molded with fibers and other anisotropic reinforcements to yield composite and hybrid materials. This simple "mix and match" approach has allowed the plastics engineer to utilize a small library of polymers to produce a bewildering array of useful products capable of possessing extremes of property values. The latest addition to this palette is graphene, a single atomic layer of carbon whose existence had been known for a long time but which was produced and identified only as recently at 2004. Andre K. Geim and Konstantin S. Novoselov of the University of Manchester, UK, were awarded the 2010 Nobel Prize in Physics for their ability to isolate this single sheet of carbon atoms. As a result of their accomplishment, the landscape of polymer nanocomposites is changing. It is true that carbon-based materials such as diamond, lonsdaleite, and graphite have been known to mankind for ages. However, renewed enthusiasm in the polymer nanocomposites research community is primarily due to the special properties

of graphene that can be transferred to plastics and the fact that graphene is derived from inexpensive precursors. The price and performance advantages of graphene challenge carbon nanotubes (CNTs) in nanocomposites, coatings, sensors, and energy-storage-device applications. And then there are applications that can only be dreamed about. Indeed, in the words of Andre Geim, Graphene is a wonder material with many superlatives to its name.¹ This is evident from the huge surge of studies in the current literature. Why such an interest in graphene? Is this simply graphene "hype," or are there application opportunities for graphene-based composite structures? This review attempts to address both these questions based on emerging trends in graphene-based polymer nanocomposites (GPNC). The scope of this work is further broadened by suggesting many possibilities that await GPNC researchers.

Graphene, the Wonder Material

A frequently cited property of graphene is its electron transport capacity. This means that an electron moves through it without much scattering or resistance. Electron mobilities that can be attained are $\sim 20,000 \text{ cm}^2/\text{V}\cdot\text{s}$, an order of magnitude higher than that of an Si transistor.² A recent review³ suggests that with improved sample preparation, mobilities could even exceed $25,000 \text{ cm}^2/\text{V}\cdot\text{s}$. Whether the lack of a band gap in graphene

poses a challenge and whether synthesizing pur graphene (without contaminants) in large quantities (be it in ribbon form or any other) is viable or not, only future research can tell. For the moment, extraordinary electronic properties put graphene at the top of the materials chart. As a result, the possibility of replacing silicon as the basic building block of the electronic industry appears to be tantalizingly close. Note that graphene's electrical conductivity is much higher than that of copper, but its density is almost four times lower. Details on electronic properties of graphene and their implications are abundant in the literature.^{4,5}

Interest in graphene for use in nanocomposites is due to its intrinsic properties. It has been predicted that a single, defect-free graphene platelet could have an intrinsic tensile strength higher than that of any other material.⁶ Indeed, James Hone's group studied the intrinsic breaking strength of a free-standing monolayer graphene membrane (applying nanoindentation) in an atomic force microscope. They measured the mean 32 μm breaking force to be 1770 nN. They also found that the material could withstand ultra-high strains ($\sim 25\%$). These measurements allowed the team to compute the intrinsic strength of a defect-free graphene sheet to be $\sim 42 \text{ Nm}^{-1}$. Here the intrinsic strength is defined as the maximum stress that can be supported by the material prior to failure in a pristine defect-free material.⁷ The mechanical strength of graphene is remarkable in that it corresponds to a Young's

modulus of ~ 1.0 TPa. In other properties, Paul McEuen and co-workers demonstrated that a graphene membrane only one atom thick is impermeable to standard gases, including helium, providing many practical application opportunities for graphene sealed microchambers.⁸ Graphene exhibits thermal conductivity several times higher than that of copper. This means graphene is able to dissipate heat readily. Recent work on a large graphene membrane has shown the coefficient of thermal conductivity to be ~ 600 W/(m.K).⁹ Another attribute of graphene is its very high specific surface area (calculated value, 2630 mg^{-1}) compared with that of CNTs (1315 m^2g^{-1}), making graphene an attractive candidate for energy-storage applications. Rod Ruoff's group has used chemically modified graphene (CMG) to demonstrate its superior ultracapacitor cell performance.¹⁰ Novel attributes of graphene have been elaborated elsewhere.¹¹ Graphene is typically free of impurities (no metals) as opposed to CNTs, a significant advantage for the construction of reliable sensors as well as energy-storage devices.¹² Further, owing to its shape and structure, graphene may pose fewer toxicity concerns; this is a topic of current research.

All these qualities in a single nanomaterial have made physicists, chemists, and materials scientists, be they theorists or experimentalists, excited about graphene's potential. Nevertheless, the important issue is to distinguish the hype from the reality. The question is not what caused the graphene hype, but which areas can really benefit from its

discovery and how to exploit its unique properties.

Polymer chemists and materials scientists are already ahead of the curve by incorporating graphene and/or its derivatives in polymer matrices to develop applications that work. Increasing strength and stiffness by employing nanoscale reinforcement is a well-known fact. Since the isolation of graphene, its production output has increased to 15 tons per annum. Based on a recent report,¹³ the commercial production of graphene nanoplatelets is expected to exceed 200 tons per year within the next two years.

However, graphene sheets that make up graphite suffer from strong surface attraction. Unless these sheets are separated and homogeneously dispersed within the polymer matrix, the full potential of graphene-based nanocomposites cannot be realized. This is quite evident given the research that has already been done on exfoliated graphite and with carbon nanotubes.

To better appreciate the challenges and the driving force behind graphene-based polymer nanocomposites, a short review of the relevant chemistry and production of graphene from its precursor graphite warrants attention.

Production of Graphenes From Graphite

The current literature describes several techniques for graphene production, including the use of supercritical carbon dioxide for the exfoliation of graphite.¹⁴ Each method has its benefits and related drawbacks.¹⁴⁻¹⁷

Current challenges to scalable nanotube opening processes for making graphene have been documented.¹⁷ Kaner et al. reviewed the chemistry, history, production, and possible applications of graphene as honeycomb carbon,¹⁸ while Ruoff et al. reviewed the preparation methods, properties, and applications of graphene-based materials.¹⁹ Another review focused on stable graphene oxide, highly reduced graphene oxide, and graphene dispersions in aqueous and organic media, highlighting their mechanical and electrical properties.²⁰ Note that high-quality pristine-graphene is crucial to fundamental studies. Clearly, the micromechanical cleavage method of Nobelists.

Polymer chemists and materials scientists are already ahead of the curve by incorporating graphene and/or its derivatives in polymer matrices to develop applications that work.

Geim and Novoselov is not suitable for producing large quantities of graphene from graphite. Large-scale graphene-based applications such as gas sensors, ultracapacitors, or transparent conductive electrodes use a suspension or colloidal dispersion of chemically modified graphenes (CMG) or reduced graphene oxide. The latter categories of graphenes are not pure graphene and are thus termed as "defective graphene." There are several categories of defects within graphene-like structures.¹⁷ Essentially the distinction among the production methods is whether one wishes to synthesize defect-free graphenes (purity) or graphenes with defects

(structural and topological containing oxygen and other species onto the surface). The virtue of graphene with defects is its lower production cost and scalability. However, the primary drawback of graphene with defects is the loss of its electronic properties. On the other hand, defects could provide reaction sites with the wrinkled surface in exfoliated graphene sheets, which assist in anchoring polymers. In consequence, this opens up other application avenues. Therefore, not only the quality of graphene but also the applications for which it is intended dictate the production method utilized.

Graphene is the basal plane of graphite, a one-atom-thick two-dimensional honeycomb layer of sp^2 bonded carbon. When many graphene layers are stacked regularly in three dimensions, graphite is created. Graphite is unique in its chemical behavior. It can act as an oxidizing agent and also as a reducing agent. A large number of studies focus on graphite because of its ability to accommodate chemical species intercalated between the basal planes. The process of introducing intercalants is known as intercalation. In graphite intercalation compounds (GICs), the graphene layers either accept electrons from or donate electrons to intercalated species without a loss of planarity of the carbon atoms. GICs using potassium as an intercalant have been known from as early as 1841.²¹ When intercalation occurs, the interlayer spacing between adjacent graphene layers increases. As a result, the strength of existing van der Waals forces decreases. This observation led researchers to expand GIC further. One could

take advantage of the exfoliation process to make individual nanoscale graphene sheets or graphene nanoplatelets (GNPs or NGPs).

The trend to produce graphene and graphene nanoplatelets in bulk quantities centers on chemical exfoliation of graphite. In this process, graphite is oxidized (similar to intercalation) with a strong oxidizer to form graphite oxide (GO), which results in an increase in the interlayer spacing between the oxygen-containing graphene layers. Remarkably, oxidizing methods (or modified therefrom) that are used today were developed over 50,²² 100,²³ and 150²⁴ years ago. GO can contain a variety of oxygen functionalities, including hydroxyl and epoxide groups, on the basal planes with carbonyl and carboxyl groups formed on the edges.²⁵ These functional groups make GO sheets highly hydrophilic and render them prone to swelling quickly and therefore easy to disperse in water. Even with increasing humidity, the interlayer distance between the graphene layer sheets has been found to increase reversibly from 6 to 12 angstroms.²⁶ Taking advantage of this, Ruoff's group first demonstrated a solution-based process to produce almost 1-nm-thick single-layer graphene sheets.²⁷ To reduce hydrophilicity, GO sheets have been reacted with organic isocyanates, and it has been demonstrated²⁸ that the isocyanate derivatized GO forms a stable and completely exfoliated dispersion in DMF (polar aprotic solvent). As for the reaction, the formation of carbamate and amide functionalities has been proposed. This paved the way to synthesize graphene-polymer

nanocomposites where organic polymers could be dispersed in polar aprotic solvents. One nagging problem with GO, though, is its reduced electrical conductivity. This could be alleviated by thermal annealing or by chemical reduction of GO. Solvothermal reduction could provide another option.²⁹ It is important to note that complete reduction of GO (removal of defects due to oxygen-containing species) is impossible to achieve.³⁰ This is why electrical conductivity is perhaps the most reliable indicator of the extent to which graphite oxide has been reduced to graphene.³¹ This, however, raises the issue of dispersibility in aqueous and/or organic matrices. Aggregation can be a substantial problem if reduced GO sheets are not dispersed well in a polymer matrix. Both chemical functionalization³² and electrostatic stabilization³³ could alleviate aggregation of exfoliated GO sheets. Yet the possibility of the exfoliated graphene's polydispersity remains. Hersam provided a lucid perspective of polydispersity of graphene, including challenges to produce a dispersion of monodisperse graphene and how density gradient ultracentrifugation could be effective in isolating graphene sheets with varying thicknesses.³⁴ Utilizing the same strategy as carbon nanotubes to avoid aggregation due to liquids whose surface energy matched that of nanotubes, Coleman's group produced a stable dispersion of graphene by liquid-phase exfoliation of graphite.³⁵⁻³⁶ Extending these works further, the same group reported on surfactant-exfoliated graphene using N-methylpyrrolidone as solvent.³⁷ Recently, they proposed a low-cost, scalable process using water-sodium

Contd. to Page - 21



RELIANCE POLYMERS.
INFINITE GROWTH.

One of the world's largest polymer producers
across PP, PE and PVC with a capacity of
4.4 MMT per annum.

At Reliance Polymers, growth is attained through
ideation, protection, and preservation – by providing
end-to-end value-added services.

Experience the infinite at www.ril.com/polymers



PEEKAY GROUP

*A HOUSE OF AUTHORISED AGENTS & DISTRIBUTORS
A ONE STOP SOLUTION TO ALL YOUR CHEMICAL AND POLYMER
NEEDS*

*WE ARE NOW THE DEL CREDERE AGENTS OF
M/S HALDIA PETROCHEMICALS LTD.*



FOR PP/HDPE/LLDPE

OUR PRODUCT LIST

POLYMERS :-

- ❖ PP/HDPE/LLDPE -
HALDIA PETROCHEMICALS LTD.
- ❖ PVC RESIN -
FINOLEX INDUSTRIES LTD.
- ❖ PET RESIN -
SOUTH ASIAN PETROCHEM LTD.

PLASTICIZERS :-

- ❖ DOP / DBP -
PCL OIL AND SOLVENTS LTD.
- ❖ EPOXIDISED SOYABEAN OIL -
AGARWAL ORGANICS LTD.

PIGMENTS :-

- ❖ PIGMENTS -
CLARIANT CHEMICALS INDIA LTD.
- ❖ TITANIUM DI-OXIDE ANATASE GRADE -
KILBURN CHEMICALS LTD.
- ❖ TITANIUM DI-OXIDE RUTILE GRADE -
KRONOS

ADDITIVES :-

- ❖ TIN STABILISERS -
ARKEMA
- ❖ PVC STABILISERS -
POWER ADDITIVES (INDIA) PVT. LTD.

FILLER :-

- ❖ CALCIUM CARBONATE -
OMYA INDIA PVT.LTD.

LUBRICANT :-

- ❖ STEARIC ACID -
SUNSHINE OLEOCHEM LTD.

CONTACT US:

Peekay Agencies Pvt. Ltd.
Bharat Mercantile Corporation
Peekay Dealer Pvt. Ltd.

7/1, Lord Sinha Road, Lords - '506',
Kolkata - 700 071

Tel: 033-40152000/10, 2282 9483/ 9485/ 6491, Fax: 033-2282 6727,40033936

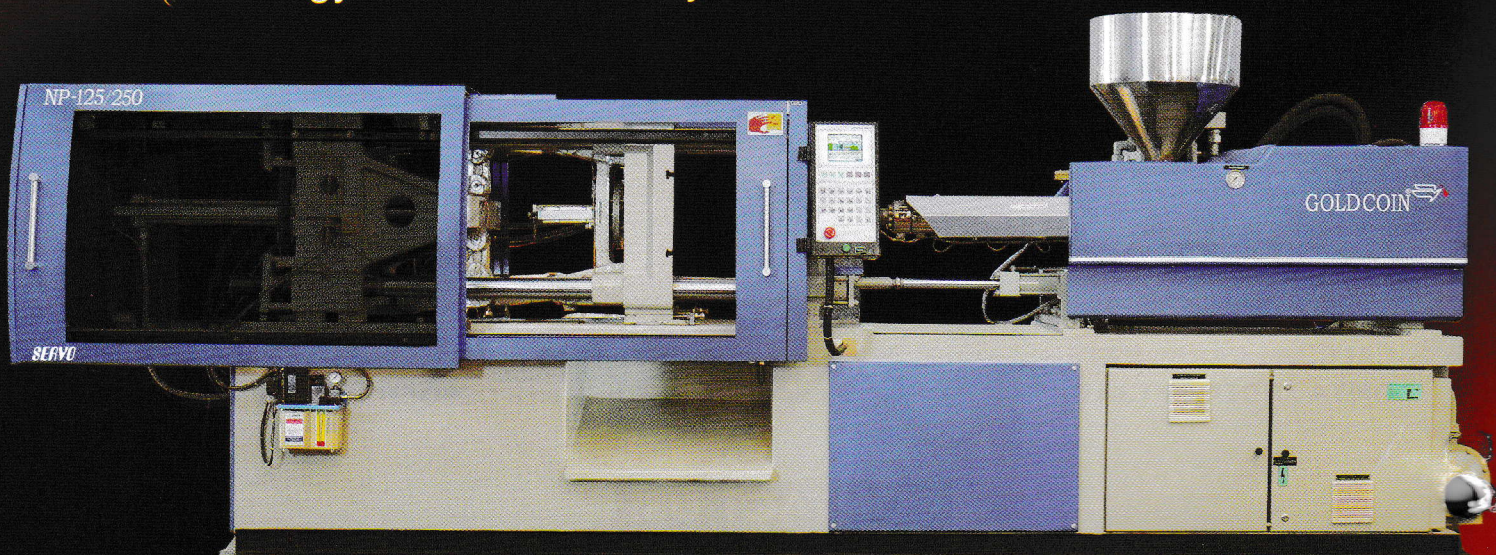
E-mail : anant@peekay.co.in
bharat@vsnl.in

MR. ANANT GOENKA :+91-9830057880, MR. RAGHAV GOENKA : +91-9830065646
MR. KARTIK PATNI : +91-9836074999, MR. DEEPAK DAS : +91-9830109785

A Promise To Commitment & Growing Satisfaction



● Energy Efficient Servo System



▲ Up to 1000 Tons

Total Moulding Solution!

An ISO 9001 - 2008 Certified Company

Reg. Office : "GOLD COIN" House, 775, GIDC, Makarpura, Vadodra - 390010, Gujarat, INDIA • Tel.: +91-265-2631211, 2632210

• Fax: +91 265 2638434 • E-mail: goldcoin@polymechplast.com • Mumbai: • Ph.: +91 - 22 - 28460878, Email: pmlmum@polymechplast.com

• Pune: +91 - 9890524568 / 9890655644 Telefax: +91 - 2135 - 660122 • Kolkatta: • Ph.: +91 - 33 - 22298400, Email: pmlcal@polymechplast.com

• Delhi: • Ph.: +91 - 11 - 65170869, 47021633, Email: pmldil@polymechplast.com • Bangalore • Ph.: +91 - 9480321017

The logo for Polymechplast, featuring the word "polymechplast" in a stylized font with a red arrow pointing to the right above the "t".

POLYMECHPLAST MACHINES LTD.

www.polymechplast.com

cholate solution for a stable graphene dispersion.³⁸ Another route to producing graphene in bulk quantities is through thermal expansion of graphite oxide. Studies have shown that for a successful GO exfoliation process, an enhancement of the c-axis spacing to 0.7 nm, brought about by completely eliminating the 0.34-nm graphite interlayer (center to center)

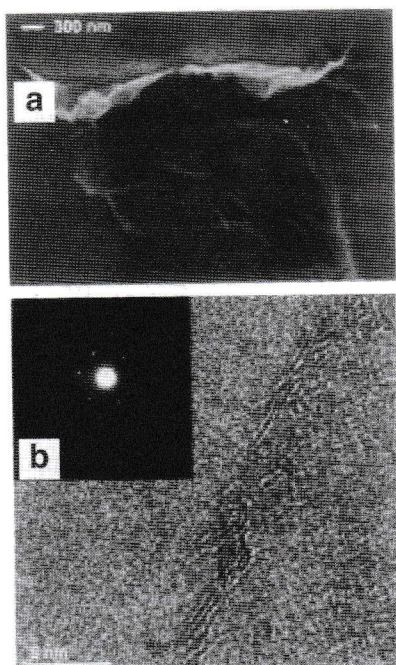


Figure 1. a) SEM image of a typical functionalized graphene flake deposited on a silicon wafer for imaging; b) HRTEM image of the edges of a typical graphene flake showing ~2–3 graphene layers. The inset shows measured electron diffraction pattern, typical for a few layered graphene. From: M.A. Rafiee, J. Rafiee, I. Srivastava, Z.Wang, H. Song, Z-Z. Yu and N. Koratkar; *Small*, 6, pp. 179–83 (2010) (Reference 61). Published by Wiley.

spacing, is necessary. Exfoliated graphene sheets produced by this method are termed functionalized graphene sheets (FGSs).³⁹ Figure 1a is an SEM image of a typical graphene flake, while Figure 1b is a high-

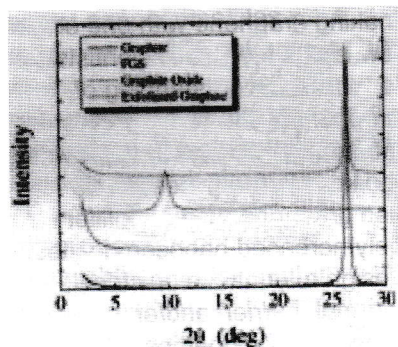


Figure 2. XRD patterns of graphite, FGS, GO and EG. From: S. Ansari and E.P. Giannelis, *J. Polym. Sci. Part B: Polym. Phys.*, 47, pp. 888–97 (2009) (Reference 55). Published by Wiley.

resolution transmission electron microscopy (HRTEM) image of the edge of a typical FGS flake; this Figure indicates that each flake is composed of ~2–3 individual graphene sheets.

Although size reduction and distortion in the flat graphene structure occurs because of thermal expansion, FGS still has high electrical conductivity. However, it is important to distinguish between different degrees of exfoliation. Expanded graphite (EG) and/or worm-like exfoliated graphite (WEG) are not fully exfoliated graphene products. This is evident from the diffraction peak at 2 in the XRD pattern that provides the dspacing. This is shown in Figure 2; it differentiates among structures of graphite, FGS, EG, and GO.⁵⁵

Chemical exfoliation from bulk graphite has revealed that both the lateral size and the crystallinity of the starting graphite determine if the final graphene products are composed of a single layer, a single and a double layer, or more layers. Starting graphite materials, such as artificial graphite, flake graphite powder, kish graphite, natural flake graphite, and highly oriented pyrolytic graphite,

also influence the graphene products.⁴⁰ It appears that artificial graphite is also suitable for the production of single-layer graphene.

The direct thermal treatment temperature and time of the treatment can be varied to design and produce ranges of graphene nanoplatelets (NGPs). Jang et al. claim to have produced NGPs having mostly one-layer to five-layer structures by the thermal shock (at 1050°C) exfoliation of GIC, followed by mechanical shearing.⁴¹ Different thickness values arise from the nonuniform expansion of GIC. Note that graphene nanoplatelets are formed by stacking of two to ten or even more nanographene sheets. It has been shown that the electronic structure evolves rapidly, with a concomitant evolution in properties, with the number of graphene layers, approaching the 3D limit of graphite at as few as ten layers.⁴² Moreover, owing to varying thicknesses and sizes, NGPs tend to agglomerate, and this could pose dispersion problems in a polymer. Therefore, for the purpose of developing graphene-based polymer nanocomposites, the importance of the synthesis method of the starting graphene material is crucial.

Manipulating graphene chemistry as well as its layer architecture can provide control over the final products.

Graphene-Based Polymer Nanocomposites

Graphite is cheap and abundant in nature. Gene and Mildred Dresselhaus started working with graphite (multilayered graphene) several decades ago, and their group's work on graphite intercalated compounds until 1980 has

been documented.⁴³ In terms of properties (stiffness, thermal, and electrical), graphite is superior to clay, and therefore it provides a unique opportunity for polymer reinforcement. The key, however, is to exfoliate graphite's layered structure and utilize it as a nanoreinforcement. For the past 20 years, researchers have incorporated either intercalated, exfoliated, or expanded graphite platelets into polymers to produce nanocomposites. Mechanical exfoliation has, of course, been known for a while.⁴⁴ Graphite nanosheets have been prepared by sonicating expanded graphite in aqueous alcohol solution.

Then graphite nanosheet-based polymethyl methacrylate (PMMA) was prepared via in-situ polymerization of MMA and nanographite sheets by sonication.⁴⁵ Drzal's group⁴⁶ exfoliated graphite using graphite intercalated compounds, and Jang's team used natural flake graphite to intercalate to form expanded graphite and then to nanographene platelets.⁴⁷ In a similar approach, using graphite that had already been intercalated and exfoliated Kaner et al.⁴⁸ re-intercalated the material with an alkali metal to make a first-stage compound, only to further exfoliate with ethanol. Subsequently they used microwave radiation heating to produce NGP of high aspect ratio with thicknesses down to 2–10 nm. In a twist, graphite nanoplatelets were incorporated into a polyacrylonitrile polymer fiber matrix by an electrospinning process to create polymer-based nanocomposite fibrils.⁴⁹

Undoubtedly, the experimental discovery of graphene as a nanomaterial has opened up new challenges for polymer nanocomposites research. In fact, different approaches to

making graphene with one or a few layers have led scientists to a better understanding of graphene's chemistry and its intrinsic properties, thus providing the knowledge necessary to use graphene as a nanofiller for polymer-based nanocomposites design to enhance electrical, thermal, barrier, and/or mechanical properties.

Not only does the number of graphene layers matter, but also their thickness, area, and shape. The critical factor in the success of polymer reinforcement is the length-to-thickness ratio, known as the aspect ratio.

When the size of reinforcing particles is greatly reduced, they tend to agglomerate and become difficult to disperse in a polymer matrix. Separation of graphene layers is crucial to avoid restacking due to van der Waals surface forces. The other issue with pristine graphene is its low wettability, i.e., low surface energy. Studies⁵⁰ have shown that at room temperature, the surface energy of graphene is only 46.7 mJ/m². This results in poor dispersion in polymer matrices with decreased mechanical properties of the resulting nanocomposites. By contrast, oxidized graphene (GO) has a surface energy of 62.1 mJ/m². In other words, oxidation and/or functionalization (introducing defects) of graphene help improve its dispersion in a polymer matrix but risk losing conductivity of the resulting nanocomposites. The main challenge in designing graphene-based polymer nanocomposites (GPNCs) with improved properties is, therefore, to disperse the individual graphene sheets in the polymer matrix. Although the preparation of PP/GO nanocomposites via in-situ Ziegler-Natta polymerization⁵¹

has been reported recently, solution phase mixing and melt blending appear to be dominant in the current GPNC literature. Current work directions in these areas are highlighted here.

Stankovich and Dikin's work showed that it was, indeed, possible to prepare a well-dispersed, homogeneous mixture of graphene nanosheets⁵² in polystyrene. To restore electrical properties of the graphene-based PS-nanocomposites, the group carried out reduction of the dispersed materials (phenyl isocyanate-treated GO with PS) with dimethylhydrazine, which also prevented agglomeration of the graphene. Furthermore, the researchers found that the percolation threshold of graphene in polystyrene-graphene composites was close to 0.1 vol%, which was one-third that of any other two-dimensional filler. Subsequent work confirmed that a homogeneous dispersion of functionalized graphene in PMMA even competed against single-walled carbon nanotube-PMMA composites.⁵³ It has been found that surface functionality and the wrinkled morphology of FGS endow superior mechanical and thermal properties to FGSPMMA nanocomposites. At 0.01 wt% graphene loading, the Young's modulus of PMMA increases by over 30%. A further increase in graphene loading to 1 wt% enhances the Young's modulus to 80% above that of PMMA. However, at 1 wt% loading, the ultimate tensile strength increases only modestly, by 20%. When these results are compared to PMMA composites containing graphite and expanded graphite (not fully exfoliated), mechanical property improvements are not as significant as those for fully exfoliated composites.⁵⁴

Giannelis⁵⁵ incorporated FGS and exfoliated graphite (EG) in a PVDF matrix by solution mixing and by melt blending. FGS-based PVDF nanocomposites showed percolation around 2 wt% compared to 5 wt% for EG-filled PVDF composites. The lower percolation threshold was ascribed to the greater aspect ratio of FGS compared to EG. This difference reveals itself in improved electrical conductivity of FGS-based versus EG-based composites, as shown in Figure 3.

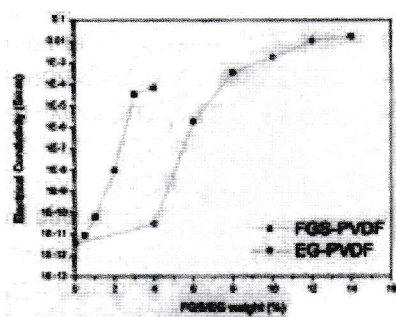


Figure 3. Electrical conductivity of FGS-PVDF and EG-PVDF nanocomposites. From: S. Ansari and E.P. Giannelis, *J. Polym. Sci. Part B: Polym. Phys.*, 47, pp. 888–97 (2009) (Reference 55). Published by Wiley.

It was found that the resistance of FGS-PVDF nanocomposites decreased with increasing temperature, indicating a negative temperature coefficient, while EG-PVDF composites showed an increased resistance with increasing temperature (positive temperature coefficient). Yongsheng Chen's group used similar solution-processable functionalized graphene to make graphene/poly (3-hexylthiophene) composites.⁵⁶ The same group prepared solution-processable functionalized graphene/epoxy composites⁵⁷ and found a low percolation threshold of 0.52 vol%. Previously, expanded-graphite-reinforced

epoxy-nanocomposites were prepared by different processing methods (direct, sonication, shear, and combined shear and sonication). When these methods were compared, shear mixing provided the best exfoliation and dispersion of graphite nanosheets and consequently the highest modulus of the resulting nanocomposites.⁵⁸ To mitigate the trade-off between mechanical and electrical conductivity, a covalent bonding approach between the graphene and epoxy matrix was utilized, and this showed a five-order-of-magnitude increase in electrical conductivity, 30% improvement in strength, and a 50% increase in stiffness in functionalized graphene-epoxy nanocomposites.⁵⁹ In another study, Koratkar⁶⁰ compared mechanical properties of graphene-based epoxy nanocomposites to single-walled and multiwalled based epoxy nanocomposites at a nanofiller weight fraction of $0.1 \pm 0.002\%$. Not only were mechanical properties better for graphene-based epoxy nanocomposites compared to SWNT- and MWNT-based epoxy nanocomposites, but the fatigue resistance behavior was also decidedly superior.⁶¹ Improved properties with graphene-based composites were ascribed to greater specific surface area (graphene-epoxy interactions) and mechanical interlocking (graphene's wrinkled surface as shown in Figure 1a). This study raises another crucial issue: whether or not effective load transfer across the graphene-host polymer interface for high performance composites occurs! The answer comes from a Raman spectroscopic study⁶² in which a single pristine graphene sheet was sandwiched between two coated layers of polymers (epoxy and poly-

methyl methacrylate) to measure interfacial stress transfer in model nanocomposites (Figures 4a, 4b).

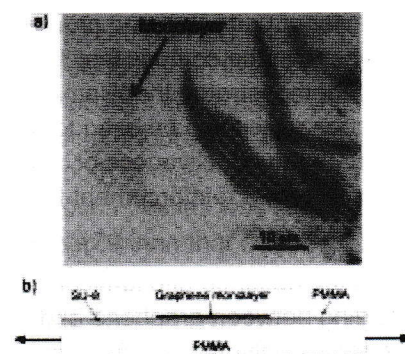


Figure 4. a) Optical micrograph showing the monolayer graphene flake; b) schematic diagram (not to scale) of a section through the composite. From: L. Gong, I.A. Kinloch, R.J. Young, I. Riaz, R. Jalil and K.S. Novoselov, *Advanced Materials*, 22, pp. 2694–97 (2010) (Reference 62). Published by Wiley Interscience.

Using continuum mechanics, this study showed that the interface between the graphene and the polymer breaks down at a shear stress of the order of 2.3 MPa. The study observed stress-induced shift of the G' band (Figure 5). A linear shift of the G' band up to 0.4% strain

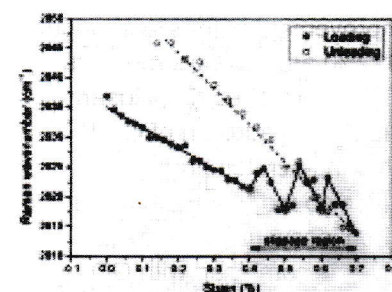


Figure 5. Shift of the G' band peak position as a function of strain. (The blue circles indicate where the loading was halted to map the strain across the flake.) From: L. Gong, I.A. Kinloch, R.J. Young, I. Riaz, R. Jalil, and K.S. Novoselov, *Advanced Materials*, 22, pp. 2694–97 (2010) (Reference 62). Published by Wiley Interscience.

was noted when the stepwise deformation was halted. The G' band position after loading and unloading exhibited slippage behavior of untreated and pristine graphene in the composites. This study demonstrated that Raman spectroscopy could be used to evaluate the effectiveness of graphene as a reinforcement for polymers.

In the absence of chemical bonding between graphene and the matrix polymer, an effective approach could be to use hydrogen bonding to strengthen the interface and to avoid debonding. For example, work on graphene/polyvinyl alcohol nanocomposites has been reported where a 76% increase in tensile strength and a 62% improvement in Young's modulus were documented by introducing only 0.7 wt% of GO.⁶³ That hydrogen bonding is critical to improving mechanical properties of GO-polymer nanocomposites has been shown by the vacuum-assisted self assembly (VASA) technique.⁶⁴ Chitosan-based biopolymer GO nanocomposites have shown a substantial improvement in tensile strength (122%) and Young's modulus (64%) compared to chitosan with 1 wt% addition of GO.⁶⁵ The anti-scratch property was also markedly improved when isocyanate terminated PU was combined with GO nanoplatelets.⁶⁶ Another study used functionalized graphene sheet (FGS) and thermoplastic polyurethane (TPU) in DMF solvent to produce a cast nanocomposite film that enhanced the electrical conductivity of TPU.⁶⁷ Exfoliated graphene layers were dispersed

into TPU using three dispersion methods: melt compounding, solvent mixing, and in-situ polymerization. Comparative results indicated that the solvent-based process was more effective in dispersing graphenes into TPU than melt processing.⁶⁸ GNP-filled TPU nanocomposites made by solution blending showed improved flame retardancy of the TPU matrix by reducing its heat release rate.⁶⁹

Drzal et al.⁷⁰ prepared GNP-PP nanocomposites by melt mixing using a twin-screw extruder and then injection-molded the GPNC to study its thermal, viscoelastic, and barrier properties. A loading of 3 vol% was found to reduce

the coefficient of thermal expansion of PP by ~ 25% in both transverse and longitudinal directions. In addition, the thermal conductivity was significantly enhanced. Also, the oxygen permeability was reduced. Electrically conductive PET-based graphene nanocomposites have been prepared by melt compounding.⁷¹ Macosko reported on melt-compounded polycarbonate-graphene nanocomposites and found both dispersion and orientation to be important to enhancing composite properties.⁷² Using solvent blending and melt-mixing techniques, J.M. Tour introduced GO as a flame retardant nanoadditive into thermoplastics

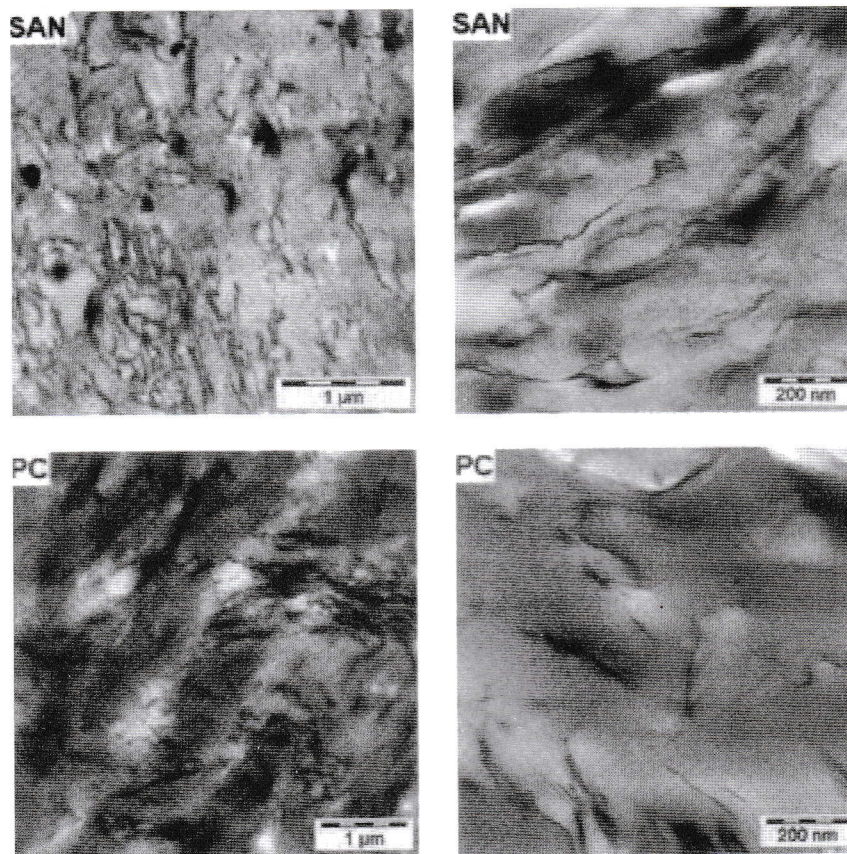


Figure 6. TEM images of SAN (top) and PC (bottom) nanocomposites containing 7.5 wt% TrGO with different magnifications. From: P. Steurer, R. Wissert, R. Thomann, and R. Mulhaupt, *Macromolecular Rapid Comm.*, 30, pp. 316–27 (2009) (Reference 74). Published by Wiley Interscience.

such as HIPS, ABS, and PC. This study⁷³ showed that GO could be used to fabricate polymer nanocomposites where decreased flammability is desired. Melt-extruded thermally reduced graphite oxide (TrGO) or exfoliated GO based polymer nanocomposites using several polymers as matrices were studied.⁷⁴ Owing to the low bulk density of TrGO, solution blending was done with the base polymers to premix TrGO at various loadings and then to melt-compound the additive with the base polymer in a mini-twin-screw extruder. TEM images of SAN and PC based TrGO nanocomposites (Figure 6) show effective exfoliation and uniform distribution of TrGO. Mechanical and electrical properties of TrGO-based polymer nanocomposites were then compared to multiwalled carbon nanotube (MWCNT) and conducting carbon black (CB)-based polymer nanocomposites.⁷⁴ Kim made a detailed solution and melt blended study by incorporating FGS and isocyanate-treated GO

(iGO) in different model polymeric systems.⁷⁵ Modifying graphite nanosheets (GN) with surfactant, and incorporating it into HDPE, a meltblended nanocomposite was prepared that showed pronounced improvements in mechanical properties.⁷⁶ When volume resistivity properties between melt-blended HDPE/GN and HDPE/carbon black (CB) nanocomposites were compared, HDPE/GN nanocomposites exhibited a lower percolation threshold than that of HDPE/CB. Even HDPE/GN nanocomposites had better melt-flow properties than HDPE/CB.⁷⁷ A new design twist was imparted when GNPs were coated with paraffin to reinforce LLDPE. Results indicated that the percolation threshold was dramatically decreased as compared to the uncoated GNP-LLDPE nanocomposites.⁷⁸ A recent study has compared melt-blended followed by injection-molded GNP-HDPE nanocomposites to composites filled with commercial carbon fibers (CF), carbon black (CB),

and glass fibers (GF). GNP-HDPE nanocomposites showed equivalent flexural stiffness and strength to HDPE composites reinforced with CB and GF but slightly less than that of CF composites at the same volume fraction (Figure 7a). The impact strength of the GNP-HDPE nanocomposites was significantly higher⁷⁹ than that with the use of all other reinforcements (Figure 7b).

Recently, Cai and Song discussed the behavior of various graphenepolymer nanocomposite systems and the difficulties they present.⁸⁰ The conclusion is that graphene acts as a reinforcing phase in polymer matrices. The challenge in dispersing graphene platelets in commodity and engineering thermoplastics during processing is the clue to the commercial success of GPNC development. Current research trends provide several strategies to mitigate the dispersion problem while exploiting the multifunctional properties of graphene as a nanomaterial.

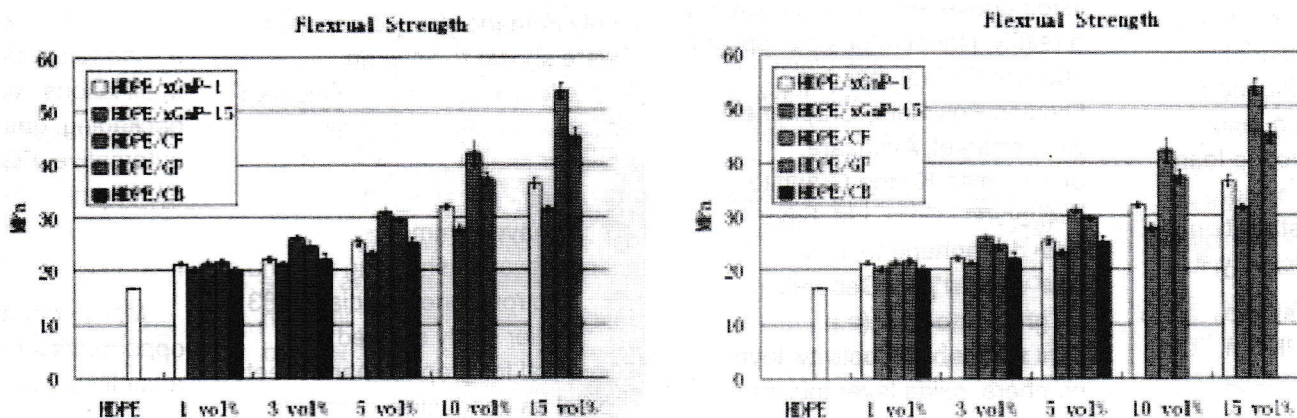


Figure 7. a) Flexural strength of various HDPE composites; b) impact strength of various HDPE composites. From: X. Jiang and L.T. Drzal, *Polym. Compos.*, 31, pp. 1091–98 (2010) (Reference 79). Published by Wiley Interscience and the Society of Plastics Engineers.

Possibilities Abound

The superiority of graphenes over carbon nanotubes as reinforcements stems from easy access to the graphitic precursor material, the cost, the scalable method, and its orientation flexibility (morphology). GPNCs can be formulated via different strategies and with different types of polymers such as thermoplastics, thermosets, elastomers, and TPEs. Potential application areas include laser mode locker to thermal to bipolar plates to energy storage to sensors to structural adhesives to barrier to gases. The diversity of applications is obvious from an examination of the following studies. Owing to wavelength-independent ultrafast saturable absorption, Tang et al. used a graphene-based PVDF nanocomposite membrane as a saturable absorber for a high-power fiber laser mode locker.⁸¹ The optically triggered actuation property is dependent on the integrity of the aromatic network of graphene.

Exploiting this characteristic, graphene-based thermoplastic polyurethane nanocomposites were shown to have an excellent infrared light-triggered actuation.⁸² The group also showed how functionalized graphene-epoxy composites could have commercial potential for lightweight shielding materials for electromagnetic radiation.⁸³ An earlier study showed the potential for graphite nanosheets to act as conductive pigments for resin shielding coatings.⁸⁴ Graphite nanoplatelets-based paste showed promise for use in thermal-interface materials.⁸⁵

NGP-polymer composites have been reported⁸⁶ to show impressive bulk conductivity over 200 S/cm, which could find applications in fuel-cell bipolar plates. Graphene-based nanocomposites can be a promising catalyst support material for polymer electrolyte membrane fuel cell (PEMFC).⁸⁷⁻⁸⁸ A biopolymer (chitin)-based hybrid nanocomposite was used as a glucose biosensor.⁸⁹ Recently, Pumera⁹⁰ reviewed in detail progress in constructing highperformance electrochemical sensors and biosensors. The possibility of utilizing NGPs in brominated and nonbrominated vinyl ester nanocomposites for flammability performance improvements has been explored.⁹¹⁻⁹² Functional graphene-based polymer nanocomposites have been studied for gas-barrier applications. Recently, the trustees of Princeton University received a patent for graphene-elastomer nanocomposites where FGS had been dispersed in vulcanized natural rubber, styrene butadiene rubber, PS-isoprene-PS, and PDMS.⁹³ The patented work could find a wide range of industrial applications, including food packaging, gasketing, and automotive. FGSsilicone foam nanocomposites showed enhanced thermal stability and heat dissipation efficiency.⁹⁴

Many commercial application opportunities for GPNC have recently begun to surface.

Conductive inks based on graphene can be used as a cheaper alternative to silver-based ink to print RFID antennas

and electrical contacts for flexible displays. Similarly, NGP-based materials could protect an aircraft against lightning strikes. Sheet molding compounds (SMC) are being developed for automotive industries. Automotive applications could include fuel systems (charge dissipation), tires (heat dissipation while enhancing stiffness), bumpers/fenders, and body components that require electrostatic spray painting.

Conductive inks based on graphene can be used as a cheaper alternative to silver-based ink to print RFID antennas and electrical contacts for flexible displays.

The creation of several start-ups that provide graphene materials - including XG Sciences, Graphene Energy, Angstrom Materials, Vorbeck Materials, Graphene Solutions, and Graphene Industries—confirms the commercial potential for graphenebased nanocomposites (GPNC). Indeed, the different applications listed above are rapidly becoming a reality. Nanomaterials suppliers such as Cheaptubes Inc., Ovation Polymers, Graphene Supermarket, Avanzare, and Xiamen Knano Graphite Technology Corp. Ltd. have added graphene to their product portfolio. Depending on graphene type (e.g., dimensions, conductivity, layer numbers, oxide layer thickness, dispersions) and its intended application, graphene could cost from \$0.25 to \$2000 per gram. Key findings from Lux Research

suggest graphene's price/performance profile threatens MWNTs in composites, coatings, and energy-storage applications. As production increases, the prices of graphene would decrease even more. According to this study, 95 graphene sales are poised to grow from a value of \$196,000 in 2008 to \$59 million in 2015.

Conclusions and Outlook

Graphene research has exploded, catching the world's attention, because of the materials' electron transport capability. The chemistry part has just started to unfold. Chemically-modified graphene has provided the platform for exploring structure-property relations of nanocomposites.

In addition to conventional polymerization methods, other techniques such as atom transfer radical polymerization (ATRP),⁹⁶⁻⁹⁸ reversible addition fragmentation chain transfer polymerization (RAFT)⁹⁹⁻¹⁰¹ or nitroxide-mediated radical polymerization (NMRP), or layer-by-layer assembly are also available today to polymer chemists. Microwave irradiation is gaining attention with a view to exfoliating chemically modified graphene. These techniques will be used increasingly in the future to tailor application-specific GNPCs.

Work will continue to focus on the surface chemistry of graphene and its derivatives.

The synthesis of GO and control of type and quantity of oxygen-containing species in GO have been the primary research focus of the graphene-based nanocomposites community. More studies are expected using molecular-dynamics simulations to reveal the structural evolution and chemistry of reduced graphene oxide.¹⁰² How efficiently the knowledge gained is transferred to the real world of processing will determine the true commercial success of GNPC. For instance, an obstacle to melt-mixing graphene into polymers is its low bulk density. Strategies will surely evolve to mix graphene with polymers.

Electron microscopic techniques have played a vital role in elucidating the morphology of GNPCs including intercalation and exfoliation in assessing the interfacial structure between the graphene and the polymer matrix with nanometer resolution. Morphological details allow researchers to understand the response of all the structural details of the composite towards applied load, enabling the design of tailored materials. On the other hand, Raman spectroscopy has not only been used to characterize graphene¹⁰³ and distinguish it from graphene with defects, it has also provided the key to understanding graphene edge chemistry¹⁰⁴ and to monitoring stress transfer efficiency in a GNPC. These studies could further open up

new vistas for graphene-based nanocomposites. We believe Raman spectroscopy and electron microscopic techniques such as TEM will play major roles in designing applicationspecific GNPCs.

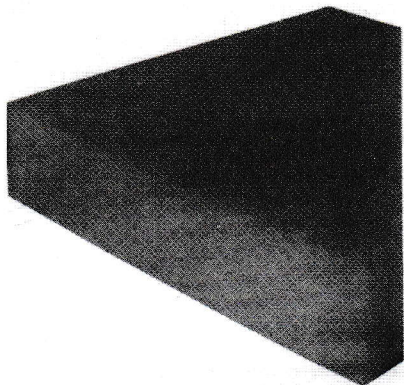
Can incorporating graphene in an elastomeric matrix provide flexible nanocomposite materials exhibiting multifunctional properties? GNPC design could involve biodegradable polymeric systems¹⁰⁵ or stimuli-responsive polymeric systems. Inserting a self-healing component in a GNPC to auto-heal or by external stimulus could address the fatigue issue that one encounters during service conditions. These novel graphene-based composites could be used in well-established application areas such as cars, aircrafts, fuel cells, membranes, and medical devices and systems.

Studies are piling up to develop engineering data and design guidelines for graphene-based polymer nanocomposites. Graphene has proven to be a multifunctional nanomaterial and is entering a crucial segment in its product lifecycle from innovation to applications. Opportunities for the future will depend on the effective use of graphene defects to design GNPCs. The main challenge that remains: how to produce a large enough volume of graphene safely and in a cost-efficient manner. That's where the race begins!

Source : *Plastics News*

NEWS AROUND THE WORLD

The First Biodegradable Polyethylene Foam



The world's first biodegradable polyethylene foam is to be launched by Nomaco Engineered Foam Solutions. Unlike competing biodegradable products, NomaGreen foam is not starch-based or bio-based, and will meet all performance requirements for packaging foam without any worry of exposing it to moisture, heat, light or mechanical stress.

A third party independent laboratory was utilized to test the foam to ensure it meets ASTM D-5511 standards for biodegradability. Results showed that after 120 days in the lab, NomaGreen achieved 49% biodegradation. The proprietary formulation allows the foam to biodegrade naturally without having to sacrifice any of the excellent performance characteristics that standard polyethylene foam provides.

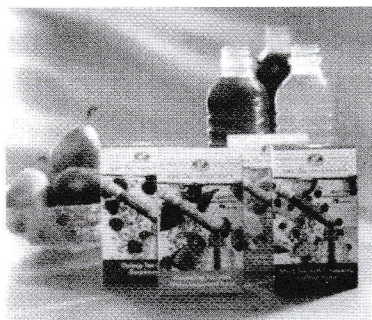
NomaGreen's biodegradation process only occurs when the foam is placed in a microbe-rich environment, such as a landfill. Also, with an indefinite shelf-life, NomaGreen will continue protecting your product for multiple uses.

Active and Smart Packaging Technology for Food and Beverage Market to Grow Rapidly

The increasing demand for fresh and quality packaged food, consumer convenience and manufacturers concern for longer shelf life of the food products is driving the market for Global active and

smart packaging technology for food and beverage market.

The global market for active and smart packaging technology for food and beverage is expected to grow from US\$15.798 mln in 2010 to US\$23474 mln in 2015, at an estimated CAGR of 8.2% from 2010 to 2015. Modified atmosphere packaging commands the largest share of the overall active and smart packaging technology in terms of value, while smart and intelligent packaging technology is witnessing the fastest growth at an estimated CAGR of 12.1%.



Active and smart packaging technology offers tremendous potential to fulfill the growing demand of food safety in various applications which include dairy products, meat and poultry, ready to eat meal segment. In active packaging, oxygen scavengers and moisture absorbers form the two largest product segments. Both are estimated to grow at a CAGR of 8% and 11.9% respectively.

North America is the major market for active and smart packaging technology because of increasing health awareness among the consumers. Therefore, it holds the largest share (35.1%) of the global active and smart packaging market.

Europe forms the second largest market for active and smart packaging technology due to increased demand for sustainable packaging and stringent regulations. Currently, the market

players are focusing on development of new products. Due to this reason, new product development accounted for the highest share of the total competitive developments in the global advanced packaging technology market for food and beverage from June 2008 to September 2010. Maximum developments are seen in oxygen scavenger product segment.

A polymer that can repeatedly heal itself when exposed to ultraviolet light

A polymer that can heal itself over and over again when exposed to ultraviolet light has been developed by materials researchers at Carnegie Mellon University and Kyushu University. The substance could potentially be used to create products that repair themselves when damaged, including self-healing medical implants or parts for vehicles such as aircraft.

When the polymer is cracked it can swiftly be prepared without the need for heat or glues by simply pressing both sides of the material together and applying UV light.



Researchers found that they could break the material into pieces and then reassemble it at least five times. They believe that with further development they could create a material that could heal itself many more times. Other self-healing materials have relied on microcapsules containing a healing agent, which break open when a crack forms.

However, once the healing agent has been used up, the material loses its self-healing ability. The new polymer is cross-linked with trithiocarbonate bonds -- carbon atoms bonded to three sulphur atoms, two of which use their second bonding position to attach to another carbon atom.

Contd. to Page - 31

A VISIT REPORT ON CHINAPLAS 2011

IPF delegation of 46 members, under the convenorship of Mr Dipak Gathani, visited China Plas 2011 at Guanzhou between 17th to 20th May 2011.

IPF delegation was very well received by the organizer M/s Adsale on the inaugural day. A group photograph was also taken. IPF was invited for the inaugural function which was attended by our Mr R.A.Lohia and Mr Amar Seth,

An interactive session with our delegation with the GM of the organizer M/S Adsale was also organized where Mr Amar Seth Chairman of IPF KC and Indplas '12 briefed about IPF KC and Indplas '12.

The exhibition was very well organized in the well equipped fair ground of 240000 sqm consisting of 2 giant halls with 3 stories. Exhibition was on an area of 180000 sqm with 2400 exhibitors present in 16 halls (500 more than last year). There were 500 foreign exhibitors. 1900 exhibitors were from Machinery sector. Latest Live Machines were on display.



IPF delegation visited exhibition for first three days and all delegates were very happy with the visit and found the visit very educative, informative with all the latest technology, inventions from the world over.

IPF was given a Complimentary stall, where IPF promoted INDPLAS '12. Large number of visitors had visited the stall and few showed their interest to participate in our exhibition.

IPF delegation visited Macau for 2 nights as pleasure trip as was originally planned.

It was indeed a very good trip. Every one has appreciated efforts of IPF. They have got a very good exposure and also knowledge about new products, machinery, moulds and accessories. All the group members were very, very supportive and co-operative. They also requested IPF to organize more such tour in future in different countries. Some of the feedbacks by the members are attached herewith. SOTC, our travel partner had made all the arrangements at Guanzhou and Macau.

Dipak Gathani
Convenor – China Plas 2011 Committee, Indian Plastics Federation

Following are the mails received from members.

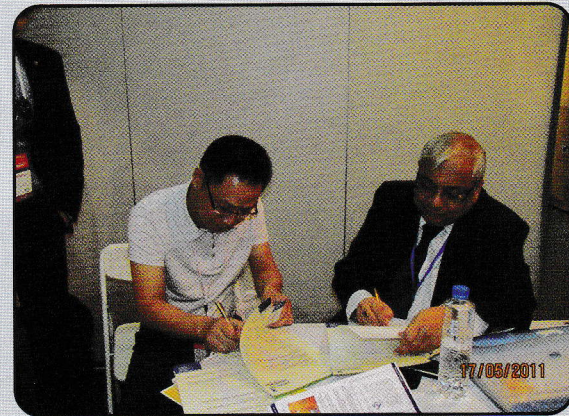
China Plas '11 was indeed a very successful, informative and a pleasurable trip and I feel fortunate to be its delegate. There were many things to learn from the trip, the pleasure we got from the exhibition was very informative and full of potential for future business with China. I think each and every delegate had something of their interest and came back more knowledgeable.

Dipak Gathani (being a convenor of the delegation) had worked on the smallest details of the entire journey as a result the delegates had a comfortable and enjoyable trip.

Starting from Kolkata Airport to Guanzhou and Macau and back home Dipak's smiling face and enthusiasm was infectious. The atmosphere throughout was calm and friendly, We felt like a family.

I wish the IPF family all success in their business and personal spheres.

S.Sultan
 PLASA POLYMERS



It was indeed a fabulous tour which was very well arranged and organized. Though I hardly knew anybody before I joined the group but I was extremely comfortable with the group as it was a very homely feeling. These contacts will help me forever.

Again the credit goes to you for taking time out from your busy schedule and arranging and managing 45 people which is a herculean task. Look forward to meeting you soon.

Manish Bansal.
 BANSAL MARKETING LTD



I would like to thank IPF team especially Mr Dipak Gathani for the efforts taken to make this business trip memorable.

The visit to and arrangements at China Plas were wonderful. The pleasure trip to Macau was the icing on the cake.

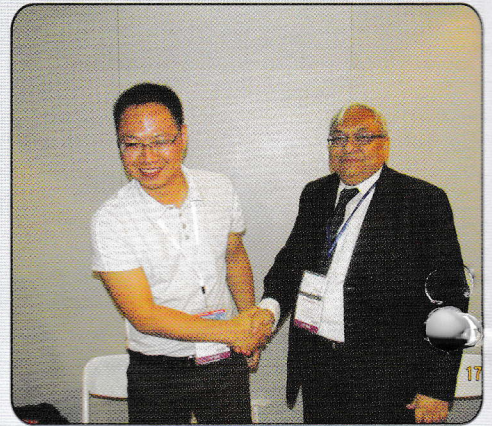
I am a regular business traveler but this trip may be remembered as the best trip ever.

Thanks again for the efforts and wish to join you on the future trips.

Amit Agarwal
VINTECH POLYMERS PVT LTD

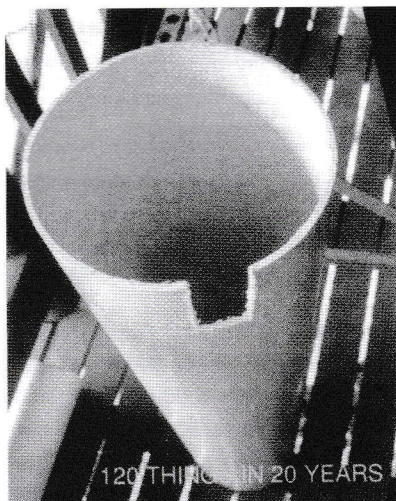
७ दिन मैं चांद अजनबियों से ऐसी हुई दोस्ती सबने बिताये मिठे लम्हे साथ साथ..
गुंजों में खिला चिनाप्लस का त्यौहार, अनेक देशों की आधुनिक और नविन विचारों को करते हम स्वीकार।
मौका की सुन्दरता से की सबने आंखे चार, और इसकी चकाचौंध देख हुये सब नीहाल।
चंद दिनों में ऐसा भाईचारा सबसे हो गया..
वापस आके जब २ दिन एक दूसरे की सकल नही देखी ऐसी लगा की कोई अपना कहीं खो गया
जिन्दगी में हम जहां भी जायेंगे याद रहेंगी ये यादें, याद आयेंगे दोस्तों के संग बिताये पल, ईश्वर से इच्छा है सबको स्वस्थ रखें सबको सदा रखें अपने कार्य में सफल!

RISHI ONDHIA



When UV light is applied, one of the carbon-sulphur bonds is broken, producing two radicals -- molecules with a free, unpaired electron. These radicals then react with other thriothiocarbonate groups to form new carbon-sulphur bonds, while breaking others to form more free radicals.

Economic recovery to stimulate PVC market



GBI Research is expecting global PVC demand to grow at a compound annual growth rate of 6.9 percent to reach around 64.3 million metric tons in 2020.

GBI said: "The impact of global economic downturn has resulted in the slowdown in the construction industry worldwide. As more than 50 percent of the PVC is used in construction applications, there has been a downturn in the demand of PVC in many countries in the last few years. But as the economies recover from the recessionary times, the demand for PVC is expected to grow at a faster rate in the coming years to 2020."

The London-based research group says in its PVC Global Market Dynamics to 2020 report that China is driving the majority of the demand for PVC in the world.

For the Asian region as a whole, demand for PVC in 2009 was nearly 16.7 million metric tons, it says.

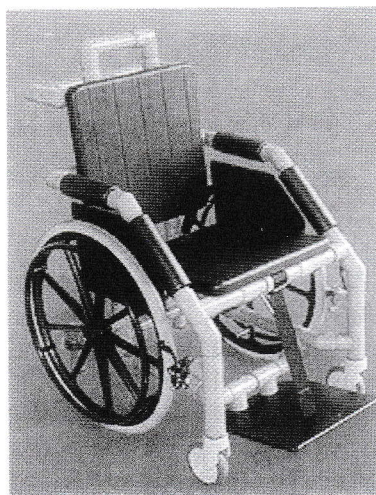
GBI said: "The GDP of countries like China and India in Asia are growing at rates higher than the global GDP growth

rates. Construction industry, which is the key market for PVC, is also growing very fast in these countries. The strong economic growth along with large population enables high growth rate in the consumption of PVC in these countries."

Europe is the second largest consumer of PVC in the world, with demand in 2009 estimated at 6.1 million metric tons. In the same year, North American demand for PVC was close to 3.9 million metric tons.

PVC demand in South and Central America is growing steadily. This region consumed around 2.4 million metric tons of PVC in 2009.

All-plastic Wheelchair Highlights Rotomolding



Norwegian company EasyRoller AS has introduced a new version of its all-plastic wheelchair that features a one-piece body and chassis component produced in rotationally molded polyethylene.

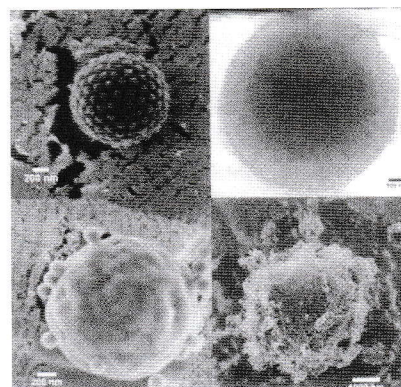
The single-piece rotational molded body and chassis replaces a frame constructed by welding together ABS tubes, which has been used on the original version of the wheelchair since its launch by Hemnesberget-based EasyRoller in 2000.

The new body and chassis part measures 105 cm. high and is manufactured by rotational molder

Partnerplast AS of Åndalsnes, Norway. It comprises seat, frame and footrest and is said to be less costly and quicker to produce than the previous welded assembly.

The all-plastic EasyRoller was originally developed to overcome some of the everyday challenges that users of traditional metal wheelchairs are faced with. These include corrosion when used in damp environments and problems passing through security and medical scanners.

Armor protects drug-releasing polymers



Researchers decorated the hollow structures—microscopic polymer-based sacks of liquid—with a variety of nanoparticles. The work suggests the possibility of designing drug-release vehicles with "stealth" capabilities that can go undetected by the body while releasing the drug. Details are reported in the *Journal of the American Chemical Society*.

Advances in polymerization have led to a surge in the creation of vesicles made from polymer molecules. Such vesicles have interesting chemical and physical properties that make these hollow structures potential drug-delivery vehicles.

Researchers at the University of Warwick were convinced that even more strength, and interesting tailored properties, could be given to the vesicles if they could add an additional layer of colloidal armor made from a variety of nanoparticles.

The work was inspired by the ability seen in some forms of plankton and bacteria to build an extra natural layer of nanoparticle-like armor.

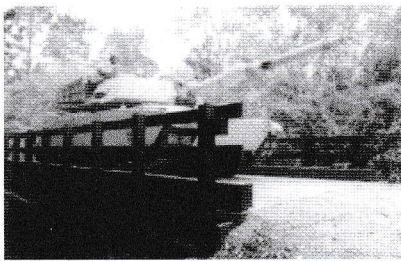
One of those armor types was a highly regular packed layer of microscopic polystyrene balls. This configuration meant the researchers could design a vesicle that had an additional and precise permeable reinforced barrier for drug release, as a result of the crystalline-like ordered structure of the polystyrene balls.

The researchers also succeeded in using the same technique to add a gelatine-like polymer to provide a "stealth" armor to shield vesicles from unwanted attention from the body's immune system while it slowly released its drug treatment.

This particular coating absorbs so much surrounding water into its outer structure that it may be able to fool the body's defense mechanism into believing it is in fact just water.

The researchers had the idea of simply giving their chosen colloidal particles or latex-based armor the opposite charge to that of the polymer vesicles, to bind them together. This turned out to be even more effective and easy to manipulate and tailor.

Recycled plastic ties coming to some U.S. railroads



The U.S. railroad is about to get a minor makeover.

Axion International has won a \$15 million contract to make railroad ties made from recycled plastic, the company announced yesterday.

The railroad ties will specifically be made of Recycled Structural Composite (RSC), the signature recycled plastic composite

developed by Axion in conjunction with Rutgers University. RSC is a thermoplastic composite produced from 100 percent recycled consumer plastics (such as milk jugs and laundry detergent bottles) and industrial plastic waste.

Axion's deal to provide replacement railroad ties over the next three years is with an unnamed company purported to be "one of the largest railroads in North America," according to a recent SEC filing by the company.

About 20 million railroad ties per year are replaced in the U.S. by the railroad industry as a whole, according to Axion. But that could change once these replacement ties are in place, as Axion claims its RSC railroad ties are longer-lasting than typical creosote-treated wood railroad ties.

The New Jersey-based company got the chance to publicly prove the strength of its plastics after scoring an almost \$1 million contract in 2009 to make bridge parts from recycled plastic for the U.S. Army at Fort Eustis in Virginia. A now famous photo of a heavy U.S. military tank crossing the recycled plastic bridge made its way around the Internet at the time, gaining attention. The bridge spanned 40 by 80 feet, and had a high-load rating of 130 tons. Since then, Axion has been commissioned for two more bridges, the most recent one announced last month for U.S. Army's Camp Mackall installation at Fort Bragg, N.C. The company provides the bulkheads, pilings, I-beams, I-beam girders, and ties for the bridges.

"Axion's RSC is inert and contains no toxic materials. It will not leach, nor warp and is impervious to insect infestation. Because it is lighter than traditional materials, transporting RSC is less expensive and reduces energy costs," Axion said in a statement.

The plastic railroad ties themselves are also recyclable, according to Axion.

"This contract represents our first sizable order in the domestic rail tie

market and the entire management team is extremely proud of this achievement," Axion President and CEO Steve Silverman said in a statement.

Plastic vs. Plastics...

Are we making parts out of 'plastic' or 'plastics'. Which is correct? What is the difference?

The word 'Plastic' refers to something which is flexible or malleable. Although most synthetic polymers are flexible, there are a many materials which also have these properties including lead, butter, clay, and beeswax.

The word 'Plastics' refers to polymeric materials... these can be synthetic or natural, thermoset or thermoplastic, and semi-crystalline or amorphous.

In the industry, the two terms are used almost interchangeably. Much of the industry literature has completely ignored the difference between the two since few people actually know the difference between the two term. I have used the word plastic in place of plastics because it reads better in many cases. For example, 'The best **plastic** for the application is ABS' reads better than 'The best **plastics** for the application is ABS'.

Eco-friendly aerosol-replacement applications using Flair™ technology



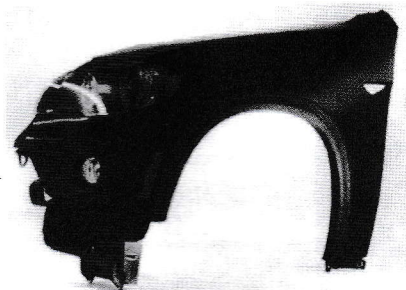
Exciting new advances in aerosol replacement are to be introduced at Interpack 2011 with the debut of packaging and dispensing applications based on its revolutionary Flair™ technology by Afa Dispensing Group. Afa is a world leader in technologically advanced liquid dispensing systems.

Products from the hygiene and sanitation, personal care, and home and garden sectors, will demonstrate the practical, cost-effective and environmentally-friendly benefits of the Flair™ platform for as a dispensing platform for liquids, fluids, high-viscosity products, soft food and a variety of other products that are susceptible to oxygen degradation.

Flair™ is an air-based, all-plastic, highly-effective, non-pressurized alternative to aerosols. It offers the excellent spray pattern and sustained spray of an aerosol, with consistent dispensing in quality and quantity, however without environmentally-harmful VOCs. It also provides a safer, non-pressurised replacement packaging solution as no propellant gases are used. Flair™ allows consistent dispensing in quality and quantity of a small droplet sized spray from start to finish regardless of viscosity, for both periodic and continuous applications. The product can be dispensed as a foam, spray, mousse or plain liquid, with or without measured doses.

Products have a longer shelf-life and sterility due to the airtight nature of the system. This helps branded products to be differentiated in the marketplace. Flair™ offers all-round cost price advantages, as the packaging cost of the liquid is significantly lower when compared to the cost of traditional aerosol packaging.

Demand Robust for Polyolefins in China and India



Preliminary estimates show that demand growth has been quite healthy in the two major markets - China and India, as per ICIS. Polyethylene (PE) demand in China (measured as local production plus

imports minus exports) rose 13% to 17.4 mln tons while polypropylene (PP) demand increased by 6% to 13.9 mln tons fortifying the country's position as the largest polyolefin consumer and importer in the world.

Data from the Chinese customs showed that the country imported 1.384 mln tons of low-density PE (LDPE), 2.478 mln tons of linear-low density PE (LLDPE), 3.495 mln tons of high-density PE (HDPE) and 4.8 mln tons of PP in 2010.

Imports of LDPE and LLDPE increased by 3% and 13% respectively while inflows of HDPE dropped by 9% and PP by 6% as local producers expanded their market share following commissioning of new plants.

In India PP continued to shine with demand (measured as local sales plus imports minus exports) rising 18% to around 2 mln tons during April-December 2010, according to local industry estimates. Demand for the fiscal year 2010-11 was expected to touch 2.6 mln tons, up from 2.2 mln tons in 2009-10. Raffia and biaxially oriented PP (BOPP) film were the key drivers. PP consumption in each of these two sectors has gone up by over 20% in 2010.

New BOPP lines were commissioned; additionally polyester film prices doubled during the year helping BOPP film makers. Rapid expansion of the Indian PP market and introduction of anti dumping measures from Saudi Arabia, Singapore and Oman resulted in a decline in exports and imports.

PP exports for April-December 2010 were down 2% to 475,000 tons while imports dropped by about 18% to 250,000 tons. HDPE demand for the year was up by about 7% at 1.1 mln tons while LLDPE rose 9% to 760,000 tons. LDPE was the only exception as high prices and tight supply resulted in demand declining by about 5% to around 250,000 tons during April-December 2010.

New line of thermoplastic polyurethane offers a broader temperature operating range



Huntsman has developed the first product in a new line of thermoplastic polyurethane (TPU) that offers a broader temperature operating range than standard grades and is a good all-round performer in industrial applications where compromise is not an option.

IROGRAN® A 92 K 5031 DP has been formulated with the needs of modern manufacturing in mind. It can be extruded or injection molded to create elastomer components for heavy-duty engineering equipment, engines and hydraulic systems where working conditions may reach up to 130°C or drop as low as -40°C. Offering high strength at room temperature, a low compression set at 100°C and consistent form retention and stability up to 120°C, IROGRAN® A 92 K 5031 DP is a practical material for the manufacture of pneumatic tubes, spiral hoses, timing belts and cable jackets employed in high temperature applications such as automotive brake and engine systems.

The product's good anti-burst properties and capacity to resist long-term exposure to oils, hydrolysis, chemicals and abrasion also makes it a reliable base material for hydraulic seals. Helmut Witt, New Business Development Manager at Huntsman Polyurethanes, said: "In the production of flexible elastomeric parts, the most successful materials are those that offer infinite processing possibilities and performance scope alongside consistent quality. IROGRAN® A 92 K 5031 DP is made using a special technique developed by Huntsman.

Source : *Polymers Business*

MONTHLY CIRCULAR OF THE FEDERATION

CIRCULAR NO. 46/2011 :

Sub: Membership of the Federation

The Federation has received the following applications for membership of the Federation :

1. a) Name & Address of the Applicant Firm : **M/S. SHREE GANESH MANUFACTURING**
55, Canning Street,
'B' Block, 1st Floor
Kolkata - 700 001
- b) Class of membership : **Manufacturer Member**
- c) Proposed by : M/s. Motors & Controls
- d) Seconded by : M/s. Shubham Plastic Pvt. Ltd.
- e) Name of representative : Mr. Suresh Agarwal
- f) Items of manufacture : Manufacturer of Polythene (Plastic) Bags,
Tubes & Plastic Film etc.

2. a) Name & Address of the Applicant Firm : **M/S. SKILL DYE CHEM (P) LTD.**
2, Ho-Chi-Minh Sarani
Room No. 5A
Kolkata - 700 071
- b) Class of membership : **Manufacturer Member**
- c) Proposed by : M/s. Express Tin Containers (P) Ltd.
- d) Seconded by : M/s. Stretch Plast
- e) Name of representative : Mr. Rajesh Agarwal
- f) Items of manufacture : Manufacturer of Plastic Bags & Leno Bags.

3. a) Name & Address of the Applicant Firm : **M/S. MODERN DYES & CHEMICAL CO.**
38, Armenian Street
Kolkata - 700 001
- b) Class of membership : **Dealer Member**
- c) Proposed by : M/s. Rajda Sales (Cal) Pvt. Ltd.
- d) Seconded by : M/s. Stretch Plast
- e) Name of representatives : 1) Mr. Narendra Kr. Suchak
2) Mr. Bharat Kr. Suchak
3) Mr. Arpit Suchak
- f) Items dealt in : Dealer of Organic Pigments, PVC Resin,
Titanium Dioxide (Rutile) Germany and Additives

4. a) Name & Address of the Applicant Firm : **M/S. AAYUSH POLY PACK**
54/4, Canning Street
Kolkata - 700 001
- b) Class of membership : **Dealer Member**
- c) Proposed by : M/s. Motors & Controls
- d) Seconded by : M/s. Shubham Plastic Pvt. Ltd.
- e) Name of representative : Mr. Shyam Sunder Bajaj
- f) Items dealt in : Dealer of Plastic Bags, Tubes, Sutli, Stretch
Film, Garbage Bag & Cello tapes etc.

(Circulated in terms of Article 15 of the Articles of Association of the Federation)



MALSON™

MALSONS POLYMERS PVT. LTD. **MFRS. OF : MASTERBATCHES AND COMPOUNDS.**

56E, Hemanta Basu Sarani, 4, B. B. D. Bag (East), Stephen House
4th Floor, Suite No. 57 ABC, Kolkata - 700 001 (West Bengal), India
Ph. No. +91-33-22623124 / 3125, 22429745, +91 98303 36400, Fax No. +91-33-2243309
E-mail : malson@karanpolymers.com, Website : www.karanpolymers.com



MALSON MASTERBATCHES, YOUR ROAD TO HIGH PROFIT AND QUALITY

PRODUCT RANGES

- Calcium/Talc filled PP Compounds
- Calcium / Talc filled PE Compounds
- Black, White and Colour Masterbatches
- UV, Optical Brightner, Anti-block, Masterbatches.
- Consumers specific Masterbatches.

USER INDUSTRIES

- Woven Sacks
- Films/ Tarpaulins
- Containers
- Non Woven Fabrics
- Carry Bags
- Moulded Goods
- PP/PE Pipes

K K Polycolor India Ltd.



A Dr. K K Kankani Enterprise. (Since 1988)

K K Masterbatches

Manufacturer of Masterbatches, Additives & Compounds.

With 22 years of Experience
Best & Continuous R&D
Wide Market Share
Consistent Quality
In - House technology

is also now venturing into-



Turnkey Projects & Technical Collaborations

From

- locating land -construction
- machineries-placement
- administrative setup-advertisement
- target market -branding.

To avail/understand our expertise
setup knowledge, kindly mail us at-
turnkeyproject@kkpolycolor.com

Providing 22 years of vast R & D
experience to have consistent quality
and varied masterbatches.

To avail & understand the scope of
technical know-how. Kindly mail us at-
technobration@kkpolycolor.com

Office & Factory:

'K K Manor', F-6, Ambattur Industrial Estate, Chennai-600 058, India. Ph: +91 44 2688 0904. Fax: +91 44 2688 0484.

E-mail: kkp@md3.vsnl.net.in Website: www.kkpolycolor.com