Transcending the conventional barriers of business to send out a message that “We Care”

The Aditya Birla Group

A US $29.2 billion corporation, the Aditya Birla Group is in the League of Fortune 500. It is anchored by an extraordinary force of 130,000 employees, belonging to 30 different nationalities. In India, the Group has been adjudged “The Best Employer in India and among the top 20 in Asia” by the Hewitt-Economic Times and Wall Street Journal Study 2007. Over 60 per cent of its revenues flow from its overseas operations.

The Group operates in 25 countries - India, UK, Germany, Hungary, Brazil, Italy, France, Luxembourg, Switzerland, Australia, USA, Canada, Egypt, China, Thailand, Laos, Indonesia, Philippines, Dubai, Singapore, Myanmar, Bangladesh, Vietnam, Malaysia and Korea.

A Global Perspective

A metals powerhouse, among the world’s most cost-efficient aluminium and copper producers. Hindalco-Novelis is the largest aluminium rolling company. It is one of the 3 biggest producers of primary aluminium in Asia, with the largest single location copper smelter. No. 1 in viscose staple fibre. The 4th largest producer of insulators. The 4th largest producer of carbon black. The 11th largest cement producer globally, the 7th largest in Asia and the 2nd largest in India.

Among the world’s top 15 BPO companies and among India’s top 4.
Among the best energy efficient fertilizer plants.

In India
A premier branded garments player.
The 2nd largest player in viscose filament yarn.
The 2nd largest in the Chlor-alkali sector.
Among the top 5 mobile telephony companies.
A leading player in Life Insurance and Asset Management.
Among the top 3 super-market chains in the Retail business.

Beyond Business

The Aditya Birla Group is working in 3,700 villages, reaching out to 7 million people annually through the Aditya Birla Centre for Community Initiatives and Rural Development, spearheaded by Mrs. Rajashree Birla. The Group’s functions span 42 schools and 18 hospitals, furthering its focus on health care, education, sustainable livelihood, infrastructure and social causes.

For more information visit www.adityabirla.com
Our Company acts as a solution provider, formulating specialized Epoxy systems for your specific performance needs.

Aditya Birla Chemicals, Epoxy Division

Thai Epoxy and Allied Products Company Limited (Thai Epoxy), has recently been transformed to the Epoxy Division of Aditya Birla Chemicals (Thailand) Limited. It is part of the Aditya Birla Group of Companies. Being the pioneer manufacturer of epoxy resins in the ASEAN region, the Company constitutes its success on its Specialized Epoxy Systems and its complete in-house Research and Application Development Center. Sustainability has also been achieved through its group-wide unique World Class Manufacturing (WCM) strategy for enterprise excellence.

Located within the prestigious Map Tha Phut Industrial Estate at Rayong Province in Thailand, the Company started commercial production in 1992 with technology from Toho Kasei Company Limited, Japan’s largest producer of epoxy resins. The Company is currently accredited and certified with ISO 9001:2000 and ISO 14001 in recognition of its quality and environment management systems.

The Company offers a wide range of epoxies and modifiers that vary in chemical structure, molecular weight, viscosity and functionality. All products are marketed under the trade name of Epotec®, including liquid, solid, solutions, blends and other multifunctional epoxy resins. Epoxy Resin, a performance polymer, is a versatile resin which finds application in adhesives, civil engineering, composites, casting and encapsulation of electrical components, and coatings including protective, marine, floor, powder, can and coil.

The Company stretches its business arms in all six continents of the globe.
Electrical and Electronic

From the beginning of the electrical and electronic industry, critical circuit components have been coated, buried or otherwise encased in dielectric materials to isolate them from adverse environmental and operational effects such as oxygen, moisture, temperature, electrical flashers, current leakage, salt spray, radiation, solvent, chemicals, micro-organisms, mechanical shock and vibrations. The first materials used for this purpose were waxes and asphalted polymer. Although these substances are still used to some extent, synthetic polymers, such as epoxy resins, are now most widely used in electrical encapsulation.

The benefits and importance of epoxy resins have been recognized after World War II by the electrical and electronic industries as a self-supporting insulating material. Our Company, since its inception, has given prime importance to this segment. As a result of intensive development work in close cooperation with our customers, our Company has compiled its present broad range of resins, curing agents and resin systems available to meet the wide variety of requirements stipulated in national and international standards.

Our goal is to continue our focus on quality and innovation thereby partnering the electrical and electronic industry in their technical progress. It is part of our philosophy not only to safeguard high and consistent product quality, but also to support our customers with information and technical service when using our products. This intent is borne out of our activities including, our willingness to supply processing information literature and other solutions to technical problems. Development of tailored systems for specific customer requirements is also part of our philosophy.

Up-to-date Research & Development facility and the services of an Application Development Center are available for product development and technical support to our customers.
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Formulation

Epotec® Epoxy Systems offer ready to use formulated products, however, users may select appropriate filler, diluents, plasticizers, modifiers, and pigments according to their choice.

Fillers are an important part of the formulation and mixed about 2 to 3 times of epoxy resin. Due to high loading, fillers become an important component for electrical and electronic manufacturers.

Several common fillers are used to achieve the desired end properties. Single or combinations of fillers can be used with or without treatment. Fillers treated by silanes provide excellent wetting, low mix viscosity, strong bonding with matrix, and prevent sedimentation during long storage.

Fillers modify the properties of the mix resulting in the following benefits:

- Reduced cost.
- Increased abrasion resistance.
- Increased rigidity and impact strength.
- Reduced shrinkage and water absorption.
- Increased heat deflection temperature.
- Modified electrical and thermal properties.
- Reduced flammability.
- Reduced flexural and tensile strength.

Selection of Fillers

<table>
<thead>
<tr>
<th>Selection of Fillers</th>
<th>Common Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silica quartz</td>
<td>High electrical properties.</td>
</tr>
<tr>
<td>Alumina trihydrate (ATH)</td>
<td>Fire retardant applications.</td>
</tr>
<tr>
<td>Alumina</td>
<td>Excellent abrasion resistance.</td>
</tr>
<tr>
<td>Mica</td>
<td>High thermal resistance</td>
</tr>
<tr>
<td>Calcium carbonate</td>
<td>Common filler, high surface area and resin absorption.</td>
</tr>
<tr>
<td>Hollow glass sphere</td>
<td>Light weight and good surface finish.</td>
</tr>
<tr>
<td>Carbon black</td>
<td>High thermal stability and semi-conducting properties.</td>
</tr>
<tr>
<td>Metallic powder</td>
<td>Modification of electrical and thermal properties.</td>
</tr>
</tbody>
</table>
Castings
In this technique, a mold is prepared to give the proper dimensions to the finished part. The molds are designed to provide minimum internal stresses as the resin shrinks during curing. The resin, curing agent and fillers are mixed and poured slowly into the mold, preferably in a vacuum to avoid air entrapment. The entire assembly is then cured either at room temperature, by its own exothermic heat or in an oven. The part is then released from the mold. Castings technique is divided into the following subcategories:

Automation Pressure Gelation (APG) or Liquid Injection Molding (LIM)
In this process, the liquid epoxy compound, including resin, curing agent and filler, are poured under gravity into steel molds under vacuum. Partially cured components are demolded and post curing is performed in oven.

Vacuum Casting
In this process, epoxy compound, including resin, curing agent and filler, are poured under gravity into steel molds under vacuum. Partially cured components are demolded and post curing is performed in oven.

Encapsulation
Encapsulation is a method of providing a protective coating on the inside of coils, closed-packed electronic assemblies and wire bundles. For saturation of components it is essential to select Epotec Resins of high flow and high wetting properties. The components finally are surrounded by a thin film of resin. Components encapsulated in this manner maintain high electrical insulation, excellent environmental protection against heat, moisture and chemicals, and also protect microelectronic assemblies with their fine interconnection.

Impregnation
Impregnation is more of a coating process which allows minimum penetration of resin into compact assemblies, whereas impregnation is a process specifically designed to ensure that the liquid resin has completely entered into interstices of assembly prior to curing. Some transformer and electronic equipment manufacture requires both encapsulation and impregnation.

NOTE: The above diagrams only demonstrate a simple representation of the associated processes. This is only for a purpose of reference, and may not be accurate in terms of details and scaling.
**Processes & Applications**

Epotec® Epoxy Systems are best known for casting into molds, cavities, cores and patterns. They are also extensively used for encapsulation (encapsulation and embedding are frequently used interchangeably), impregnation and protection of electrical and electronic assemblies and components. Usually low-pressure-reacted resins are utilized and curing is performed at room temperature to elevated temperature, up to 200°C. Room temperature curing Epotec® Systems are preferred for low voltage, small components, while heat-cured Epotec® Systems offer extremely high physical, thermal and chemical resistance. As such, heat-cured Epotec® Systems are used for medium and high voltage applications.

There are few common process techniques for use of Epotec® Epoxy Resins in electrical and electronic components.

**Potting**

Potting is a variation of casting in which the prefabricated mold, a thin shell of metal or plastic, becomes an integral part of the finished product. The resin is fluid enough to flow around the components being embedded and fills all voids, including the container. Potting is used frequently to reduce weight, avoid breakdown and prevent failure due to moisture and vibration in components.

**Encapsulation**

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1. **Automation Pressure Gelation (APG) or Liquid Injection Molding (LIM)**

   In this process, the liquid epoxy compound, including resin, curing agent and fillers, is directly pumped into a split mold which is v-mounted on a clamping machine. Only gelling step is allowed in the mold and final curing of component is performed in separate oven. This method allows to compensate for chemical shrinkage and is used extensively for mass production of insulating components for electrical industries.

   - 1. APG Clamping Unit
   - 2. Static Mixer / Buffer Tank
   - 3. Dosing Pump
   - 4. Resin Tank
   - 5. Flexibilizer / Accelerator Tank
   - 6. Curing Agent Tank
   - 7. Vacuum Plant
   - 8. Control Panel

2. **Vacuum Casting**

   In this process, epoxy compound, including resin, curing agent and filler, are poured under gravity into steel molds under vacuum. Partially cured components are demolded and post curing is performed in oven.

   - 1. Autoclave
   - 2. Static Mixer / Buffer Tank
   - 3. Dosing Pump
   - 4. Resin Tank
   - 5. Flexibilizer / Accelerator Tank
   - 6. Curing Agent Tank
   - 7. Vacuum Plant
   - 8. Control Panel

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### Typical Properties of Epotec® Epoxy Systems for Electrical and Electronic Applications

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit Method</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Water absorption 1</td>
<td>% w/w</td>
<td></td>
<td>Glass transition point</td>
<td>℃</td>
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<tr>
<td>Elastic modulus in tension</td>
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<td></td>
<td>Flexural strength</td>
<td>N/mm²</td>
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<tr>
<td>Tracking resistance (CTI)</td>
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<td></td>
<td>Arc resistance</td>
<td>sec</td>
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<tr>
<td>Tan δ at 50 Hz (23˚C)</td>
<td>% w/w</td>
<td></td>
<td>Pot life of mix (&lt; 5kg)</td>
<td>h/˚C</td>
<td></td>
</tr>
<tr>
<td>Flexibilizer</td>
<td>% w/w</td>
<td></td>
<td>Initial viscosity of mix</td>
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</tr>
<tr>
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<td></td>
<td>Filler loading (pbw 1 filler)</td>
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<tr>
<td>Curing condition</td>
<td></td>
<td></td>
<td>Filler (silica flour 300 mesh)</td>
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<tr>
<td>Physicals</td>
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<td>Processing technique</td>
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<tr>
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<td></td>
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<tr>
<td>Radiation induction (FRC)</td>
<td>sec</td>
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<tr>
<td>Total reaction time</td>
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Important Considerations for Epotec® Resins

The epoxy casting resins, generally, are liquids at processing temperature when combined with the curing agents. The mixture is cured at room or elevated temperature to the thermoset state. There are a number of common considerations involved in achieving good, solid, crack-free, bubble-free castings. These include:

**Exotherm**
Exotherm is the increase in temperature of compound above the cure temperature due to energies released as the epoxy group reacts. For fast resins it is quite possible for the center of a casting to generate bubbling due to vapor pressure, and which lead to char and explodes in extreme conditions.

**Reactivity**
Reactivity of epoxy resins while curing ideally obeys Arrhenius' law which in effect states “For every 10°C rise in temperature, the reaction rate doubles.” Hence, if a compound will gel in 30 minutes at room temperature of 25°C then if warmed to 35°C, it will gel in approximately 15 minutes; at 45°C, in 7½ minutes. Thus when heat is used as a means of achieving low viscosity, reactivity becomes an opposing factor.

**Shrinkage**
Shrinkage is the reduction in volume or in linear dimensions observed during cure. Shrinkage induces stresses which can damage pressure sensitive inserts or which can lead to crack under thermal cycling.

**Thermal Expansion**
Thermal expansion characteristics are the function of epoxy resin, curing agent, modifiers, and fillers present in formulation. In general, the more highly flexibilized the compound, the higher the expansion rate; the more highly filled the lower the expansion rate. Ideally the expansion rate of the resin should be matched to those of the inserts present or should provide an intermediate value in the case of different expansion rate of the inserts.

**Thermal Shock**
Thermal shock is a severe problem with rigid epoxy resin system. The problem is magnified when higher temperature operation is required, in so far as many flexible systems are inherently unsuited for this service because of relatively poor thermal stability. To obtain satisfactory thermal shock resistance for severe thermal cycling, sophistication in the formulation is required. Initial stresses caused by shrinkage and cure temperature should be minimized. Reversible stresses caused by the expansion characteristics of the compound should be reduced to the level of practical.

**Thermal Stability**
Thermal stability indicates the ability of the resin to serve at elevated temperature and maintain minimum specified properties. With elevated temperature aging there is generally a progressive loss of strength and an overall reduction in properties. Often there is progressive embrittlement because of loss of volatile fragments and increased cross-linking. As temperature is further increased surface charring will occur, followed by cracking and decomposition.

**Vapor Pressure**
The temperature at which the vapor pressure equals the surrounding or atmospheric pressure, the boundary between the gas and liquid disappears and the substance boils. If epoxy compound becomes too hot, this may lead to generation of gas bubbles trapped in the cured structure.

**Viscosity**
The viscosity of resin controls the quantity of filler and determines the viscosity of formulated compound. In order to assist removal of air bubbles from compound and to obtain a desired, void-free structure, it is often desirable to have low viscosity at processing temperature.
Glossary

Arc Resistance
The ability of a material to resist the action of high voltage electricals are usually stated in terms of the time required to render the material electrically conductive. Failure of the specimen may be caused by heating to incandescence, burning, tracking or carbonization of the surface.

Coefficient of Thermal Expansion
The fractional change in length (or sometimes in volume, when specified) of a material for a unit change in temperature.

Deflection Temperature under Load
The temperature at which a simple beam has deflected a given amount under load (formerly called heat distortion temperature). This is the temperature at which a specimen deflects 0.010 inches at a load of 66 or 264 psi.

Dielectric Constant (Permittivity)
That property of a dielectric which determines the electrostatic energy stored per unit volume for unit potential.

The ratio of the capacity of condenser having a dielectric material between the plates to that of the same condenser when the dielectric is replaced by vacuum. Also known as specific inductive capacity, it is expressed as:

\[ E = \frac{C_d}{C_0} = \frac{Q}{C_0V} \]

Dissipation Factor
The ratio of the power loss in a dielectric material to the total power transmitted through the dielectric.

Glass Transition Temperature (Tg)
The temperature at which the amorphous polymer changes from a glass-like brittle state to rubbery state.

Partial Discharge (PD)
Partial discharge is a phenomenon which occurs on or inside the test body when an alternative voltage of a critical level is set up or exceeded. It can be explained by the gaseous gaps (very fine pores, irregularities). The effect of internal partial discharges are particularly damaging and may shorten the service life of the insulation.

Thermal Conductivity
The measure of the ability of a material to conduct heat. For a homogenous material it is the ideal rate of heat flow, under steady conditions, through unit area, per unit temperature gradient in the direction perpendicular to the area.

Thermal Shock
The stress-producing phenomenon resulting from a sudden temperature drop.

Thermal Stability
The resistance to permanent change in properties caused solely by heat.

Tracking Resistance
Resistance of solid insulation materials against combined effect of electrical stress and electrolytic contamination. This is also known as comparative tracking index.
Disclaimer
This brochure is designed to provide you with information to the Epotec® range of Products referred to, and should be read in conjunction with the latest Technical Data Sheets (TDS) and Material Safety Data Sheets (MSDS), and may not be construed as legally binding. Nothing contained herein constitutes an offer for the sale of any product. The Company makes no warranties, either expressed or implied, with respect to its product or the results of its use, or with respect to any information provided by the Company.

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Material Safety, Handling and Storage Conditions
Due to variety of materials used in epoxy systems, please consult Epotec® Technical Data Sheets (TDS) and Material Safety Data Sheets (MSDS). TDS and MSDS are available for all Epotec® products upon request. Alternatively, visit www.epotec.info for detailed material safety, handling, and storage conditions.
Electrical and Electronic
Epotec® Epoxy Systems

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