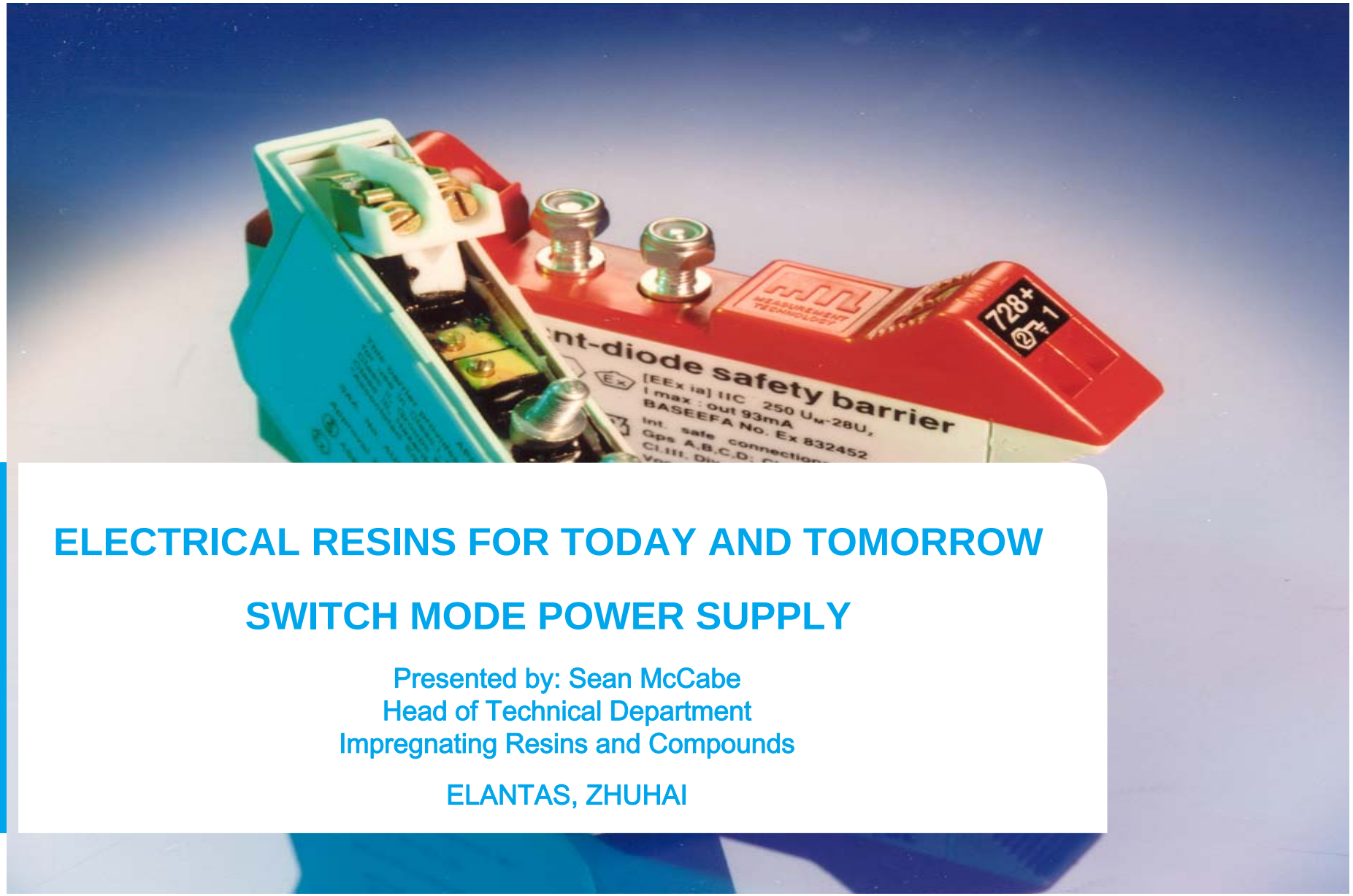


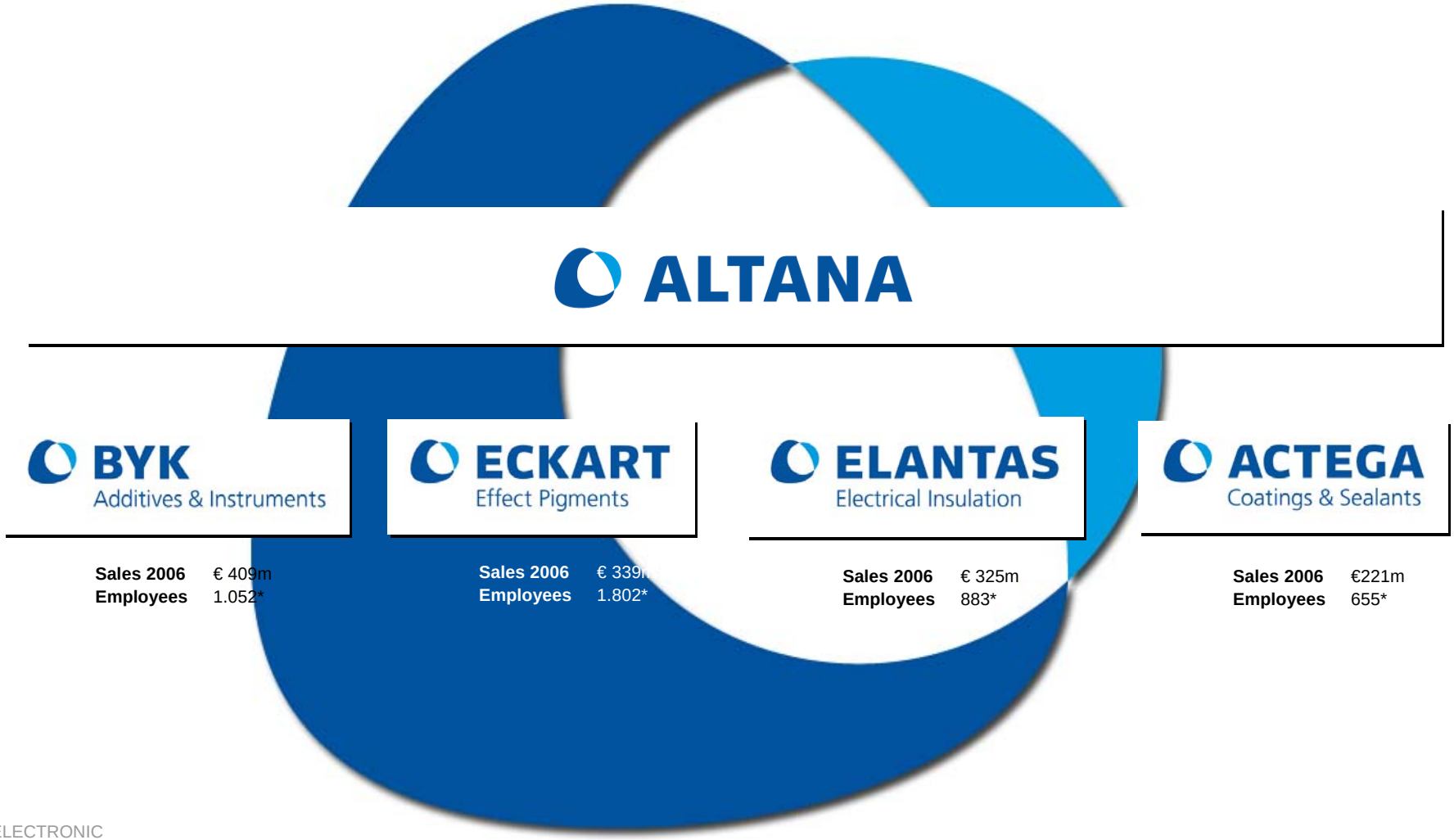
ELECTRICAL RESINS FOR TODAY AND TOMORROW

SWITCH MODE POWER SUPPLY

Presented by: Sean McCabe
Head of Technical Department
Impregnating Resins and Compounds

ELANTAS, ZHUHAI

Elantas
Group Structure



ELECTRONIC
TRANSFORMERS
S.McCABE

Sales 2006 € 1,3bn
Employees 4,500

ELANTAS
Electrical Insulation

Elantas
at a Glance

ALTANA

Sales 2006 € 1,3bn
Employees 4,500

BYK Additives & Instruments

Sales 2006 € 409m
Employees 1.052*

BYK-Chemie GmbH
BYK Asia Pacific
BYK-Cera
BYK-Chemie de Mexico
BYK-Gardner
BYK Gardner USA
BYK Japan
BYK Solutions
BYK Tongling
BYK USA

ECKART Effect Pigments

Sales 2006 € 339m
Employees 1.802*

ECKART GmbH & Co. KG
ECKART America
ECKART Asia
ECKART Benelux
ECKART Cosmetics
ECKART France
ECKART Italia
ECKART Mexico
ECKART Pigments
ECKART Suisse
ECKART Switzerland
ECKART UK
ECKART Zhuhai

ELANTAS Electrical Insulation

Sales 2006 € 325m
Employees 883*

ELANTAS GmbH
ELANTAS Beck
ELANTAS Beck India
ELANTAS Camattini
ELANTAS Deatech
ELANTAS Isolantes Eletricos do Brasil
ELANTAS PDG
ELANTAS Tongling
ELANTAS UK
ELANTAS Zhuhai

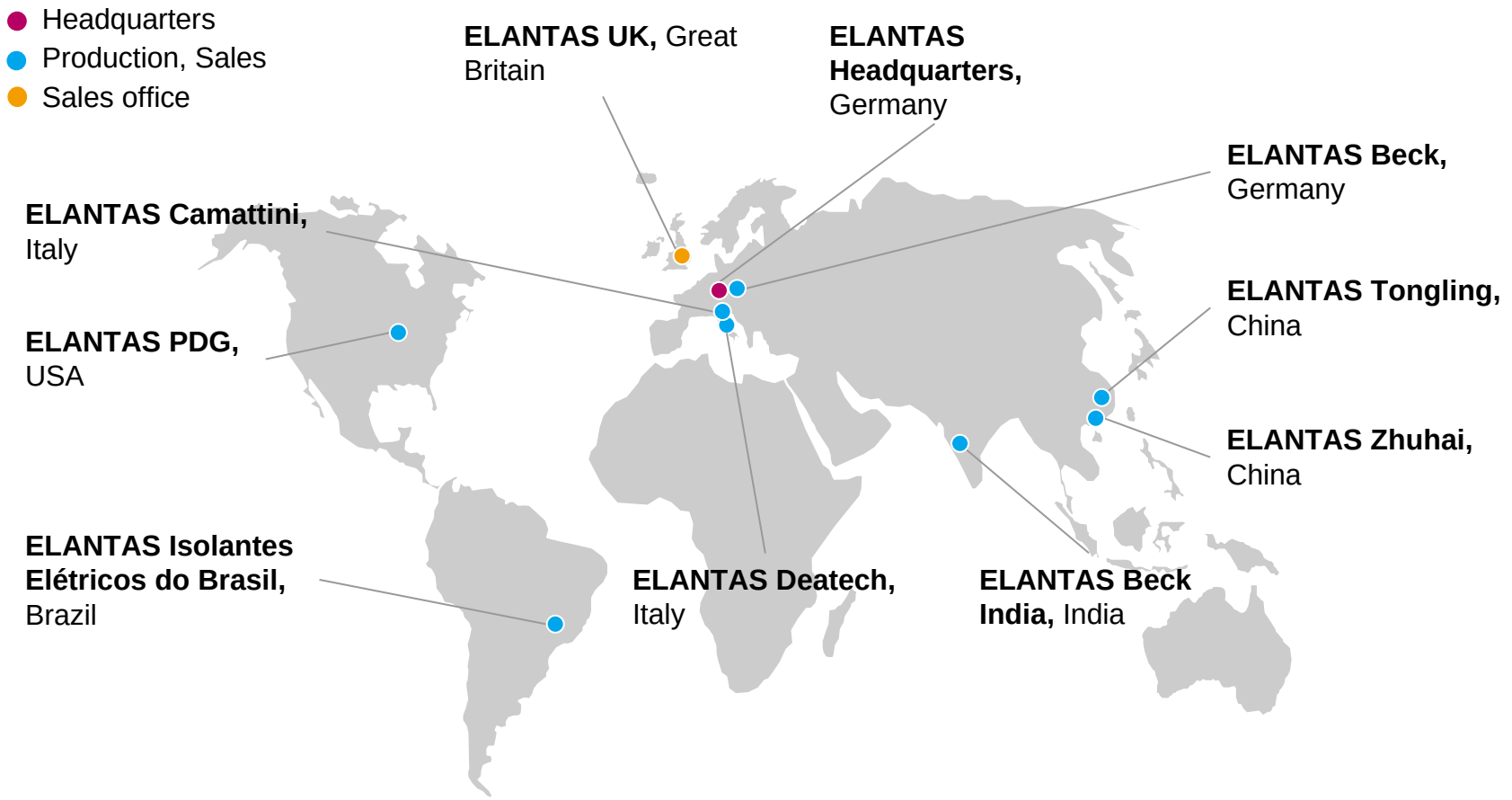
ACTEGA Coatings & Sealants

Sales 2006 €221m
Employees 655*

ACTEGA GmbH
ACTEGA Artistica
ACTEGA DS
ACTEGA Foshan
ACTEGA Kelstar
ACTEGA Radcure
ACTEGA Rhenacoat
ACTEGA Rhenania
ACTEGA Terra

***** (2006-12-31)

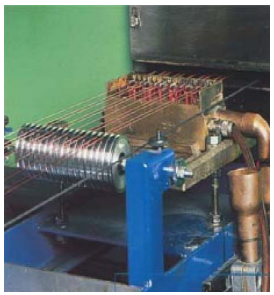
ELANTAS
Global Footprint



With production, R&D and technical service in Americas, Europe and Asia, ELANTAS is well positioned to benefit from ongoing globalization

ELANTAS
Electrical Insulation

Primary Insulation
Products and Applications

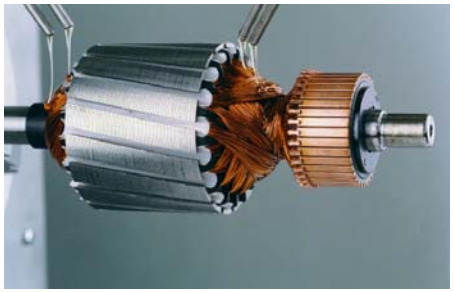
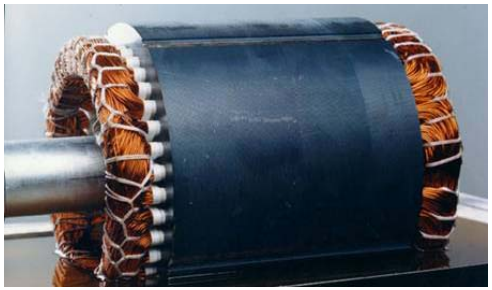


- **Wire enamels for the primary insulation of magnet wire**
- **Magnet wire is applied in electric motors, generators and transformers**

ELANTAS
Electrical Insulation

Secondary Insulation
Products and Applications

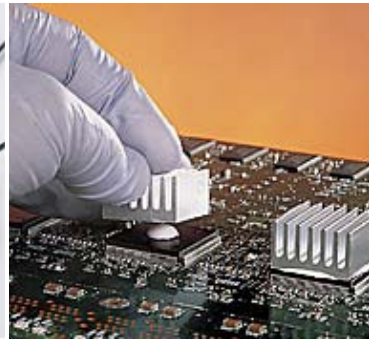
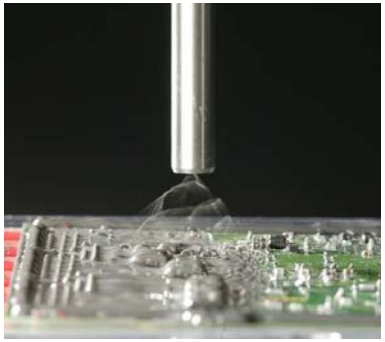
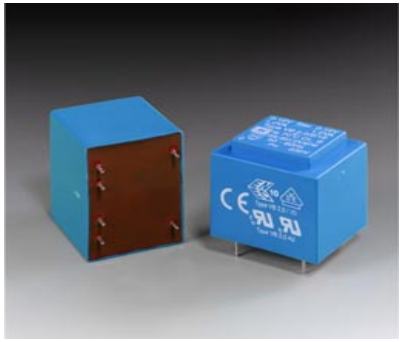


- **Secondary Insulation of winding wire after it is mounted in a device** (electric motor, generator or transformer)
- **Applied through various application techniques** (dip, roll-dip, hot-dip, trickle, VPI etc.)

ELANTAS
Electrical Insulation

Electronic and Engineering Materials
Products and Applications

- **Resin systems for the overall protection of electronic circuits and electric devices**
- **Resin systems with specific functionalities in electronic components/assemblies**

ELANTAS
Electrical Insulation

ELANTAS, ZHUHAI:
INVESTMENT AND PRODUCTION CAPABILITY

Registered Capital: 5.70 Million USD

Total Investment:9.50 Million USD

Fluid working capital:3.2 Million USD

Area of Land: 70,000m²

Building area of the first stage:12,500m²

Production Capability:

15,000 tons of high performance impregnating varnish per year.

10,000 tons of wire enamels per year

ELANTAS
Electrical Insulation

CONSTRUCTION HISTORY

- **In October 2002, Decision was made to set up Elantas Electrical Insulation (Zhuhai) Co. Ltd.**
- **In August 2003, Construction of Zhuhai plant was formally started**
- **By the end of July 2004, construction of the plant was finished and commissioning started**
- **In September, 2004, Zhuhai plant began the trial production.**

ELANTAS
Electrical Insulation

EQUIPMENT STATUS

- **Six reactors**
  (3 × 15 cubic meters, 1× 8 cubic meters, 1× 4 cubic meters,1 ×500 liters)
- **Eight dilutors**
  (5× 35 cubic meters, 2× 15 cubic meters, 1 × 1 cubic meter)
- **Ten mixers**
  (2× 3 cubic meters, 2× 5 cubic meters,3× 8 cubic meters, 3×1 cubic meters)

EQUIPMENT STATUS

- **Ten intermediate storage tanks**
- **(10 × 50 cubic meters)**

- **Fourteen raw material storage tanks**
- **(7 × 60 cubic meters, 7 × 100 cubic meters)**

- **One waste fluid collecting tank**
- **(60 cubic meters)**

- **One safety tank (50 cubic meters)**

ELANTAS
Electrical Insulation

QUALITY CONTROL STATUS

- **ISO 9000 was issued in May, 2005**
- **OHSAS 18000 & ISO14000 in 2006;**
- **TS16949 in May, 2007.**

- **Major test equipment for lab is positioned such as FTIR, TGA, DSC, Bond strength tester etc. which is enough for current quality control requirements;**

- **Technical development & management systems are applied to insure future quality.**

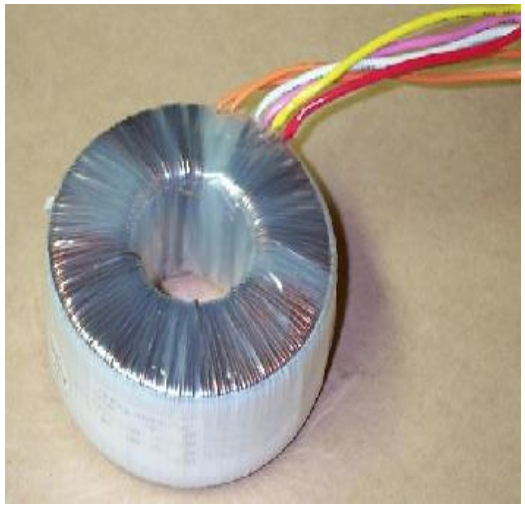
ELANTAS
Electrical Insulation

QUALITY CONTROL STATUS

- **Both Chinese and English versions of raw material specifications, testing procedure and product specification, testing procedure and production process are available;**
- **UL approval work is done and we are authorized to produce and sell all products transferred / approved from P. D. George and other sister companies.**
- **A new lab has been established with more advance equipment like VPI and Enameling machine.**

A Strategic Approach to Specific Applications –

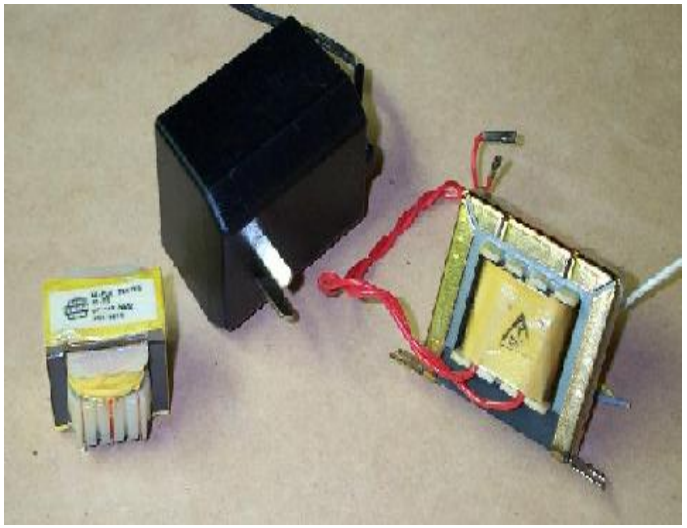
Electronic Transformers



ELANTAS
Electrical Insulation

Topics:

- Market size and development
- Electronic transformers – what are they?
- Resin requirements
- Products offered by ELANTAS
- Future resin systems

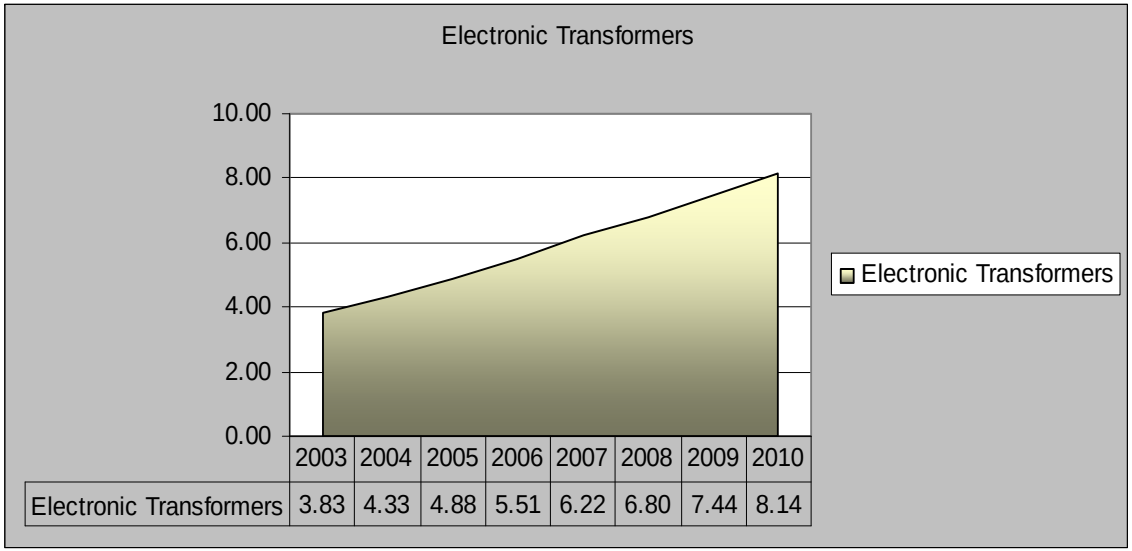


ELANTAS
Electrical Insulation

Market size and development
Electronic Transformers

	1999 - 2004	2005 - 2010
Market growth*	**__20__% p.a.**	**__10-15__% p.a.**

(volume units: Mtons)



	2003	2004	2005	2006	2007	2008	2009	2010
Electronic Transformers	3.83	4.33	4.88	5.51	6.22	6.80	7.44	8.14

Secondary data: CHEAA – appliance reference

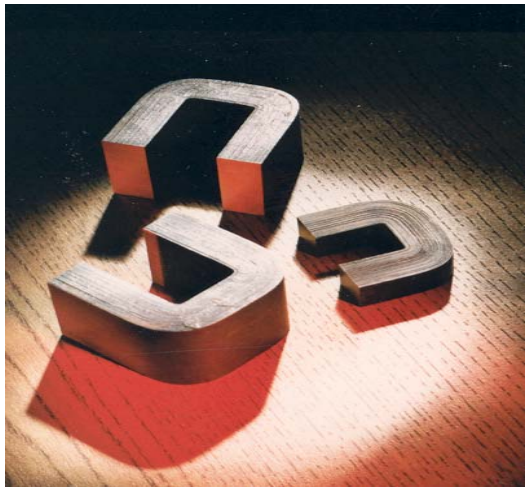
Explanation

1. **This market is dominated by USA companies who have OEM in China plus Taiwanese & Japanese bases. They continue to move production to China**
2. **This is the first industry in our field to absorb the foreign investment in China since their end product is highly labour intensive.**
3. **Future growth will be the growth of the Chinese domestic market for export.**
4. **OEM and / or foreign manufacturers focus on export but products have to be UL approved.**
5. **Many manufacturers have specified Elantas materials**

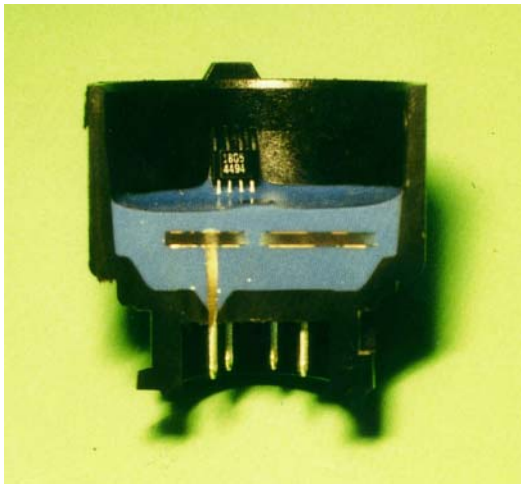
ELANTAS
Electrical Insulation

Electronic Transformers – What are they?

Component name:
Transformers
Transducers
Lightning and Surge Protection devices
Ballasts/Lighting
Capacitors/Suppressors
Switchgear

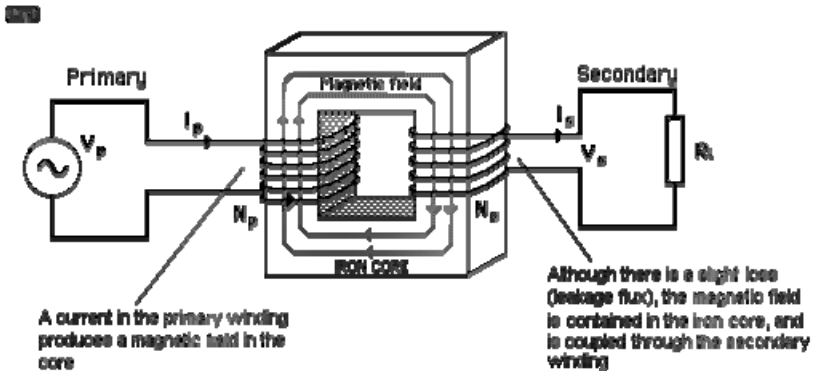


Used in:
Telecommunications
Office equipment
Automotive
Appliances
The control circuit of anything electrical!!!!



ELANTAS
Electrical Insulation

Electronic Transformers – Operation?



- **Inductance is the ability of a coil to establish (or induce) a voltage within itself to oppose changes in current through its windings.**
- **When varying current (AC) flows through a coil, a voltage is induced within the coil in a direction so as to oppose the change of current through it.**
- **Transformers are one of the major applications. These are made from "mutually coupled" coils where the magnetic field established in one coil, 'cuts' through the other coil and hence induces a voltage in the other coil. This is called 'mutual inductance'.**
- **They are used in electronics to step-up or step-down voltages. When a varying voltage (like AC) is applied to one of the coils of the transformer a voltage is 'induced' in the other coil due to mutual inductance.**

Resin functions:

- **Transformers are noisy! : Electrical varnishes help the unit resist vibration**
- **Transformer consolidation : Electrical varnishes help the unit resist wire separation, by solidifying the core and holding the conductors together within the coil.**
- **Environmental: Electrical varnishes insulate the winding and core from the environment. This insulation prevents the oxidation of core material and deterioration of magnet wire insulation due to contact with moisture or airborne impurities.**
- **Insulation of minute "nicks" on the magnet wire, increased dielectric strength of enamelled wire and fibrous and porous sheet insulation.**
- **Raised operating temperature of low-temperature sheet insulation.**
- **Fill of internal voids within the component : Playing a major role in heat transfer from "hot spots" within the part to the surface.**

Resin requirements:

- Flexible: To aid noise reduction and prevent wire movement
- Low viscosity: To facilitate penetration between fine wires
- Low exotherm / shrinkage: To prevent damage to fine wires and limit changes in inductance
- High chemical and moisture resistance: To repel the environment
- Increased electrical performance: Dielectric strength.
- Increased thermal conductivity: Dissipate heat quickly and prevent hot spots.
- Coefficient of Thermal Expansion: Solids expand in response to heating and contract on cooling; this response to temperature change is expressed as its coefficient of thermal expansion

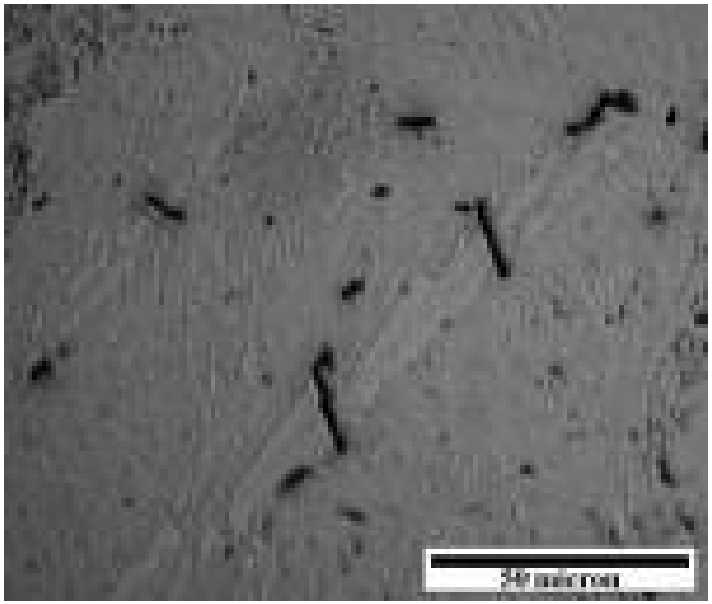
Resin functions in detail

Flexible: To aid noise reduction and prevent wire movement

Base resin used must be able to “flex” according to the frequency power of the transformer to prevent micro-cracking.

Flexibility is measured using:

Hardness Measurements	DIN 53505
Tensile strength	ISO527
Glass transition temperature	IEC1006

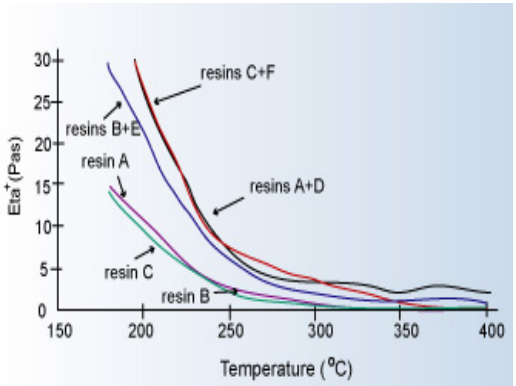


Resin functions in detail

Low viscosity: To facilitate penetration between fine wires

Viscosity is the measure of a material's resistance to flow. It is a result of the internal friction of the material's molecules. Materials with a high viscosity do not flow readily; materials with a low viscosity are more fluid.

The higher the viscosity the thicker the material
Viscosity decreases as temperature increases



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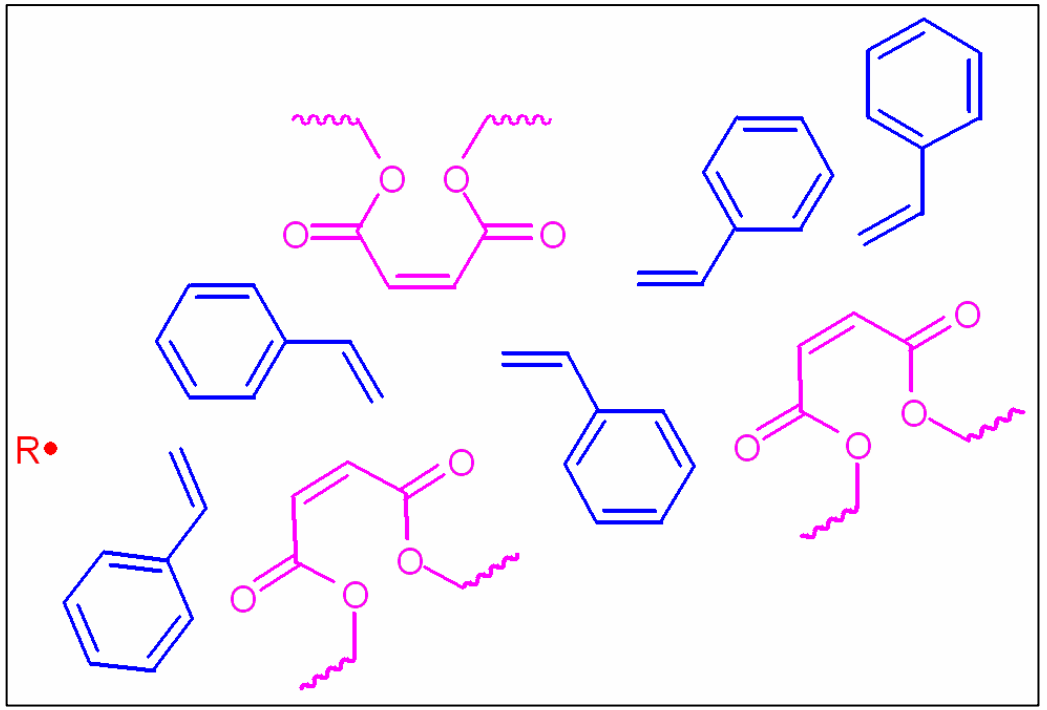
Electrical Insulation

Resin functions in detail

Low exotherm / shrinkage: To prevent damage to fine wires and limit changes in inductance

When certain polymers cure they give out heat as an exotherm - the energy dissipated in a chemical reaction. This heat is sufficient to break wires and therefore change the overall inductance



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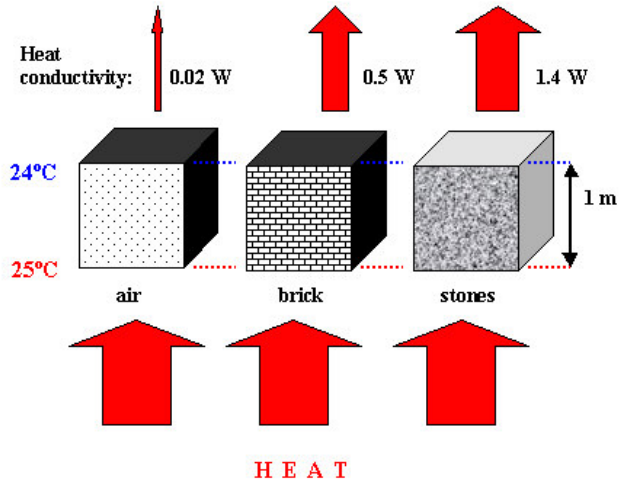
Electrical Insulation

Resin functions in detail

Increased thermal conductivity: Dissipate heat quickly and prevent hot spots.

Thermal conductivity is a measure of the heat transfer capability of the resin to prevent over-heating of the core. It is measured according to ISO 8894-1.

Inorganic fillers are used to increase this property but this can also increase viscosity.



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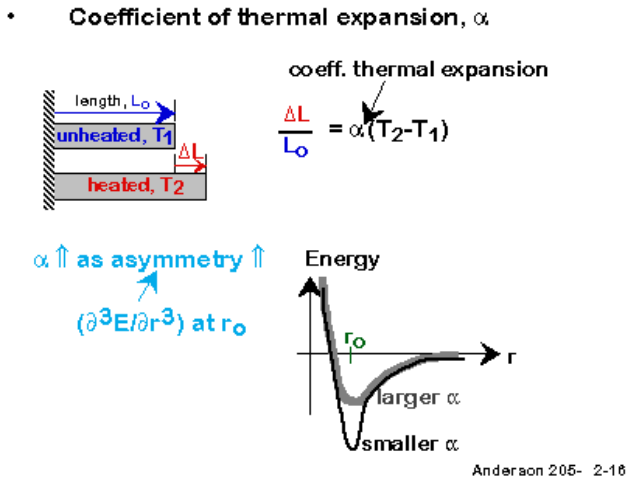
Electrical Insulation

Resin functions in detail

Coefficient of Thermal Expansion

Materials expand / contract due to changes in temperature which leads to changes in thermal vibration of the atoms in a material, and hence to an increase in the average separation distance of adjacent atoms.

The **<u>linear coefficient of thermal expansion</u>** a describes by how much a material will expand for each degree of temperature increase

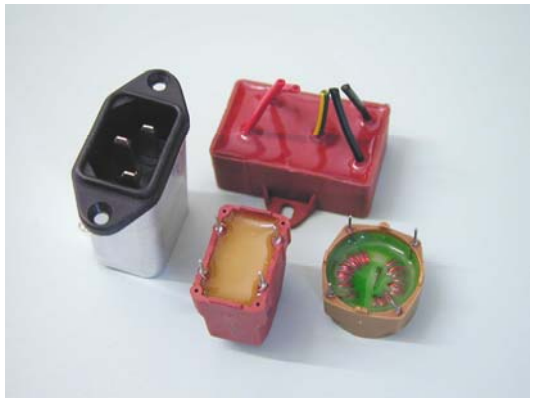


ELANTAS
Electrical Insulation

Resin profiles:

	Non-reactive Solvents	Solvent-less	Water-Reducible
Common Resins	Phenolic, Epoxies, Saturated Polyesters	Epoxies Polyurethane Unsaturated polyesters PBD resins	Saturated polyesters Epoxies
Common Solvents	Xylene, toluene	Styrene, Vinyl toluene	Small amounts of non-reactive organic solvent
Typical Cure Methods	Heat / room temperature	Heat / room temperature	Heat
Typical Process	Dip and Bake	Potting / Dip and Bake/VI	Dip and Bake
Material Tank Stability (Pot Life)	Very good	Very good	Very good
Tank Maintenance	Simple	Moderate	High
Environmental Emissions	Yes	No	No
Price	Low	High	Moderate
Disposal Costs	High	Low	Low
Typical Number of Parts	One	Two	One / two

Resins and Compounds for the Electronic Transformer Industry



ELECTRONIC
TRANSFORMERS
S.McCABE

ELANTAS
Electrical Insulation

Elantas 468 range

Uses

Impregnation of electronic components

Advantages

Outstanding Noise Reduction
Outstanding Thermal Dissipation
High Dielectric Strength
Excellent Chemical and Moisture Resistance
Excellent Tank Stability
Long product history

Application Method

Dip / Vacuum process

Chemical type

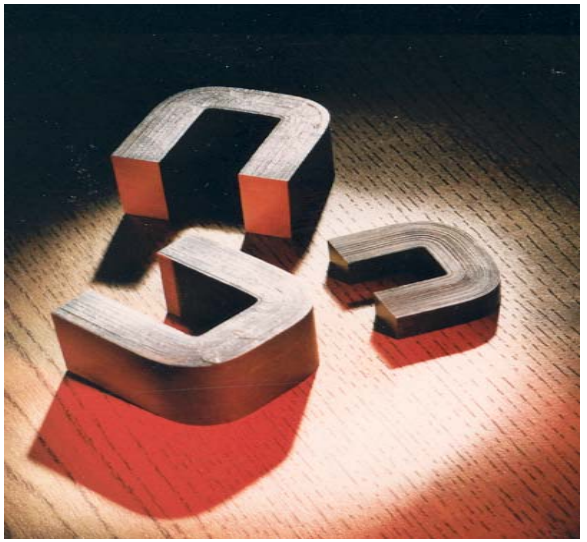
Resilient epoxy resin

Single component

Cure: 3-5hours at 135C

UL

recognized up to Class 200C



ELANTAS
Electrical Insulation

Elantas V1630 / V1380 / 009-0008

Uses

Impregnation of motors and transformers

Advantages

Fast air dry
Good penetration
Good moisture resistance

Application Method

Dip
Spray

Chemical type

Modified saturated polyesters

Single component

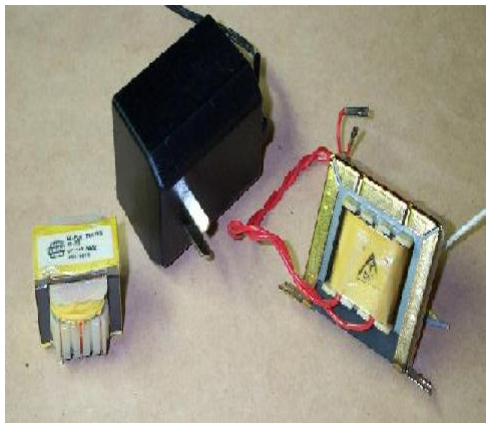
Cure 20-30 minutes at 25° C

UL

recognized up to Class 180C

CUSTOMERS

ATC Frost
Delco Remy
Signal Transformer
Johnson Electric
Various distributors



ELANTAS
Electrical Insulation

Elantas 003-1010

Uses

Impregnation of motors and transformers

Advantages

High flexibility
High bond strength
Good moisture resistance

Application Method

Dip
VI

Chemical type

Solvented saturated polyester

Single component

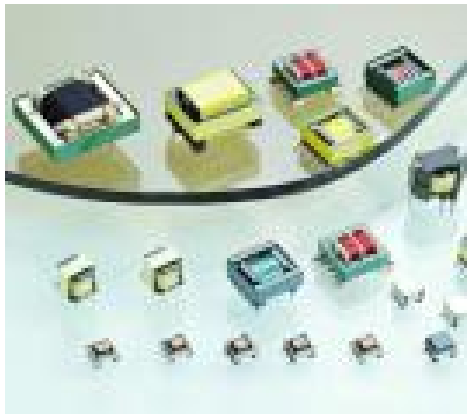
Cure 2-3 hours at 130-160° C

UL

recognized up to Class 200C

CUSTOMERS

Phillips Shanghai
Sanyo
Various distributors



ELANTAS
Electrical Insulation

Elantas U510S

Uses
Potting of electronic components

Advantages
Very flexible
Good adhesion to various substrates
Excellent thermal shock characteristics
Room temperature cure

Application Method
Potting

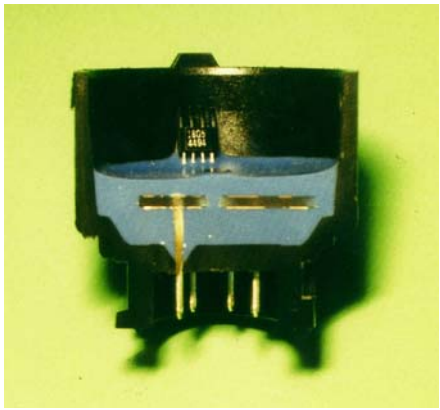
Chemical type:
Flexible polybutadiene

Dual component (100:24 pbw)
Cure 72-168 hours at 25C

UL
Not recognized by UL

Customers
Delco Delphi Electronics

Hamlin



ELANTAS
Electrical Insulation

Elantas PED 300

Uses

Impregnation and potting of transformers

Advantages

Very Flexible
Excellent for noise dampening
Can be highly filled
Excellent field history
Cost effective

Application Method

Potting

Chemical type:

Unsaturated polyester – in styrene

Dual component (100:1)

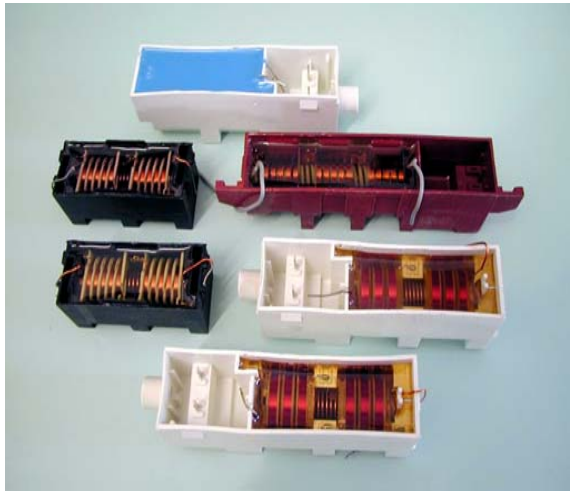
Cure 24 hours at 25° C (77° F)

UL

Recognized up to Class 180C

CUSTOMERS

Holophane
Sola
Jefferson
Actown



ELANTAS
Electrical Insulation

Altana E471-5LL

Uses

Impregnation and potting of electronic transformers

Advantages

Minimal exotherm and shrinkage.

Excellent for noise dampening

highly filled – excellent heat transfer

Long pot life and low viscosity makes this compound ideal for fine wire applications.

Application Method

Potting

Chemical type

Highly filled epoxy resin

Dual component (100:15)

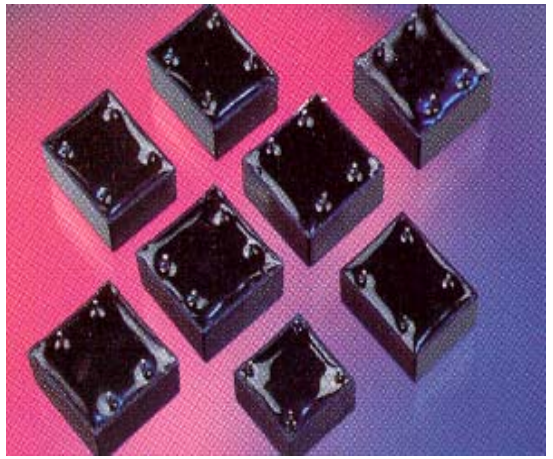
Cure 24 hours at 25° C (77° F)

UL

Recognized to UL94 V-0

CUSTOMERS

Various agents



ELANTAS
Electrical Insulation

Altana 200 Polyurethane

Uses

Impregnation and potting of high voltage electric and electronic transformers

Advantages

Good electrical properties at elevated temperatures

Excellent mechanical resiliency.

Excellent heat shock.

Low temperature cure.

Application Method

Potting

Chemical type

Filled polyurethane resin

Dual component (100:16.7)

Cure 1-2 hours at 107-121° C

UL

Not recognized by UL

CUSTOMERS

Various agents

ELANTAS
Electrical Insulation

Future Developments – Resin Choices?

Environmentally Driven

Water Based resin systems

Low emission Resins

Low viscosity solventless epoxy systems

ELANTAS
Electrical Insulation

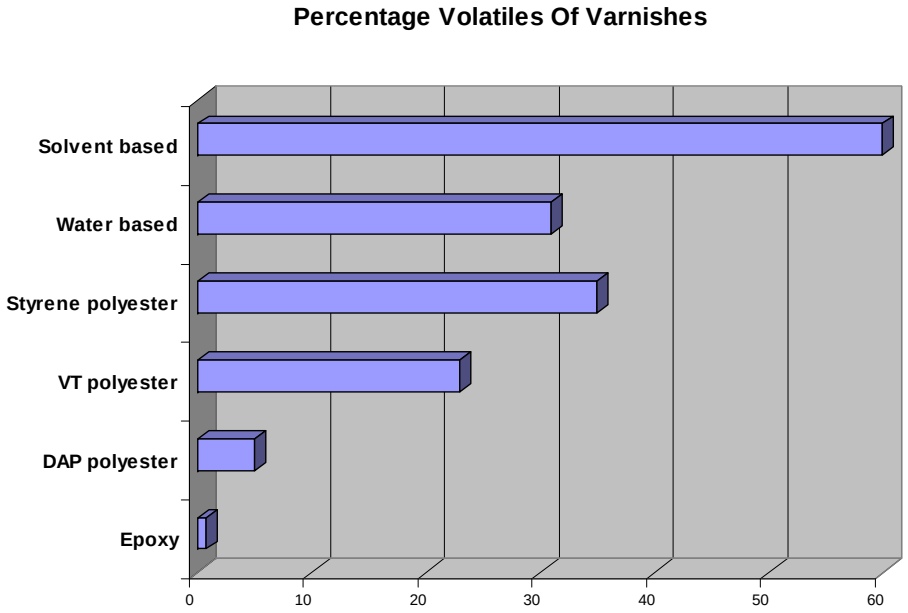
Future Developments – Resin Choices?

Environmentally Driven

EPA programs have been set up to improve air quality.

The clean air act has added an extra dimension in making a decision as to the type of varnish to use in the manufacturing of transformers and other electrical devices.

The figure below shows the typical % of VOC (Volatile Organic Compound) for each type of varnish.



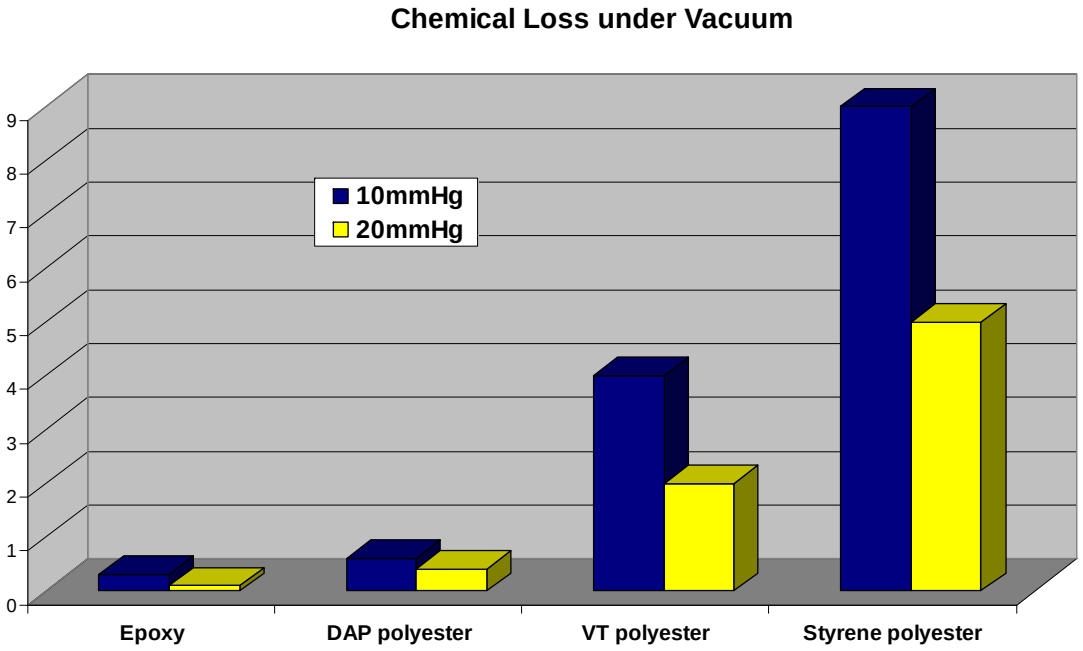
ELANTAS
Electrical Insulation

Future Developments – Resin Choices?

Environmentally Driven

The figure below shows the % volatiles stripped off under vacuum levels of 10 and 20mmHg. Solvent based and water based were not tested as the vapour pressure of the solvents and water.

The solventless epoxy and DAP systems exhibited good results

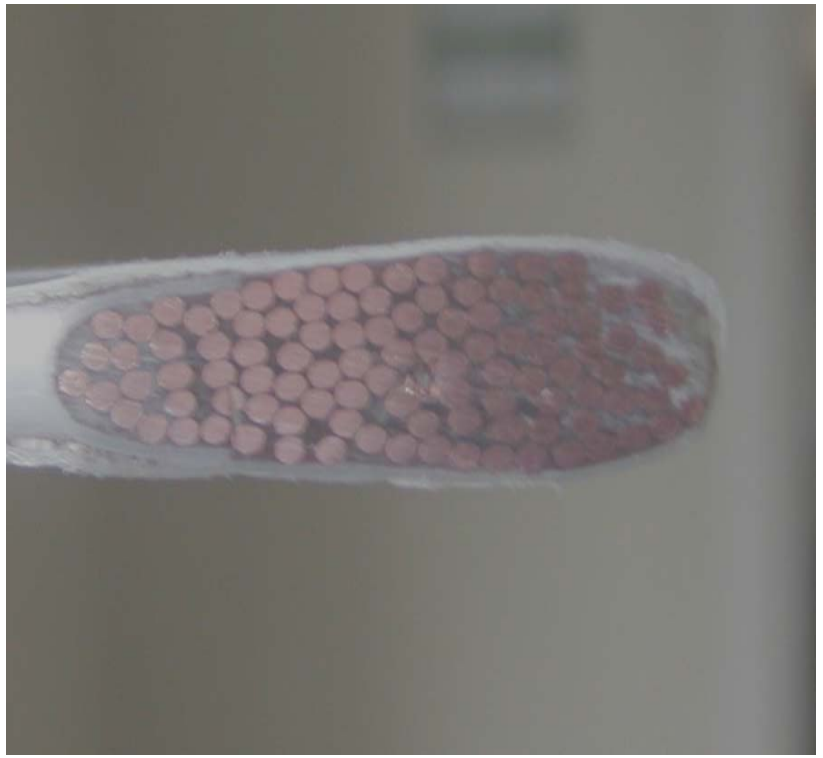


ELANTAS
Electrical Insulation

Future Developments – Resin Choices?

Temperature Rating Driven

- Filled resins to improve thermal conductivity
- High Temperature co-polymer systems
- High Temperature Epoxy Resins



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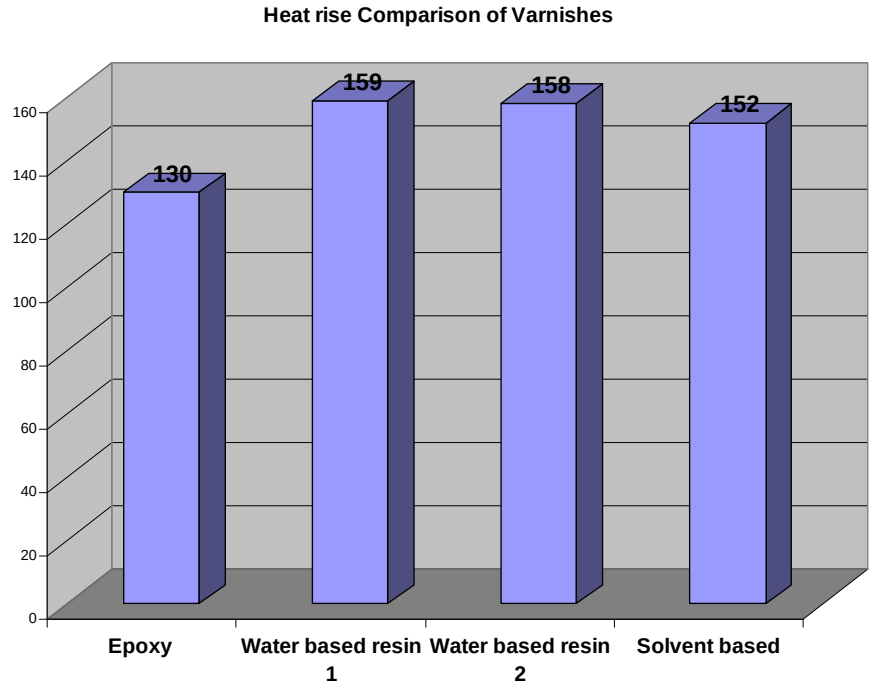
Future Developments

Temperature rating driven

- The transformer processed in the solvent-less epoxy exhibited heat rise of 20C less than the other systems.

- The reason for this is that the solvented polyester and the water based varnishes didn't meet the temperature requirement of 150C for the transformer is that when these are cure they also out-gas. These emissions cause a honeycomb effect, trapping air which is a poor thermal conductor and traps heat



Note that the acceptable upper limit for heat rise in this case was 150C.

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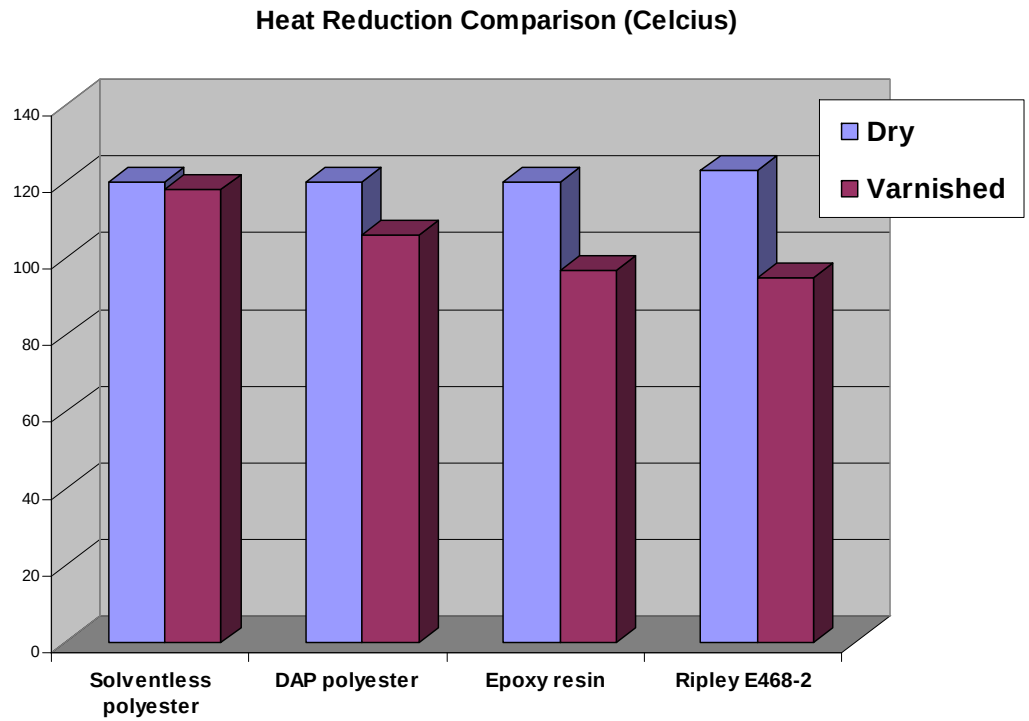
Future Developments

Temperature rating driven

The figure (below) shows how the correct choice of impregnant even amongst different 100% solids varnishes of like and dissimilar chemistries, can have varied results pertaining to heat rise.



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Future Developments

Temperature rating driven

- **The correct choice of resin has a direct effect on the heat rise of the transformer. Whilst this is a physical function of the varnish, the results directly impact the decision of the varnish choice by reflecting into the final cost of the transformer**.

- **How does heat rise and heat reduction calculate into the costing factor of the varnish?**

  Providing that the heat rise is within specified limits, the engineer will be able to achieve a significant cost reduction of the transformer by eliminating some of the core steel and magnetic wire. The major cost of the transformer is in the insulation, steel and copper. If you can eliminate even a small percentage the cost savings are real.

So? Investigate!!!

As can be seen different applications require different properties from the system used.

Investigate what exact properties are important and define in order of importance.

ALSO: The resin will be used with other insulation materials –

Good compatibility between these is essential!!!!

Check

Compatibility in the wet state

Compatibility of by-products after cure due to thermal degradation

What else must be considered?

1. COSHH – Control of Substances Hazardous to Health

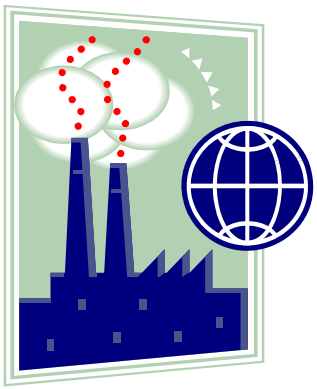
These place obligations on employers to use more safe chemicals

2.EPA – Environmental Protection Act

Limits to the release of hazardous substances into the environment

3. COST!!!

This covers the cost of the resin and also the cost of the equipment



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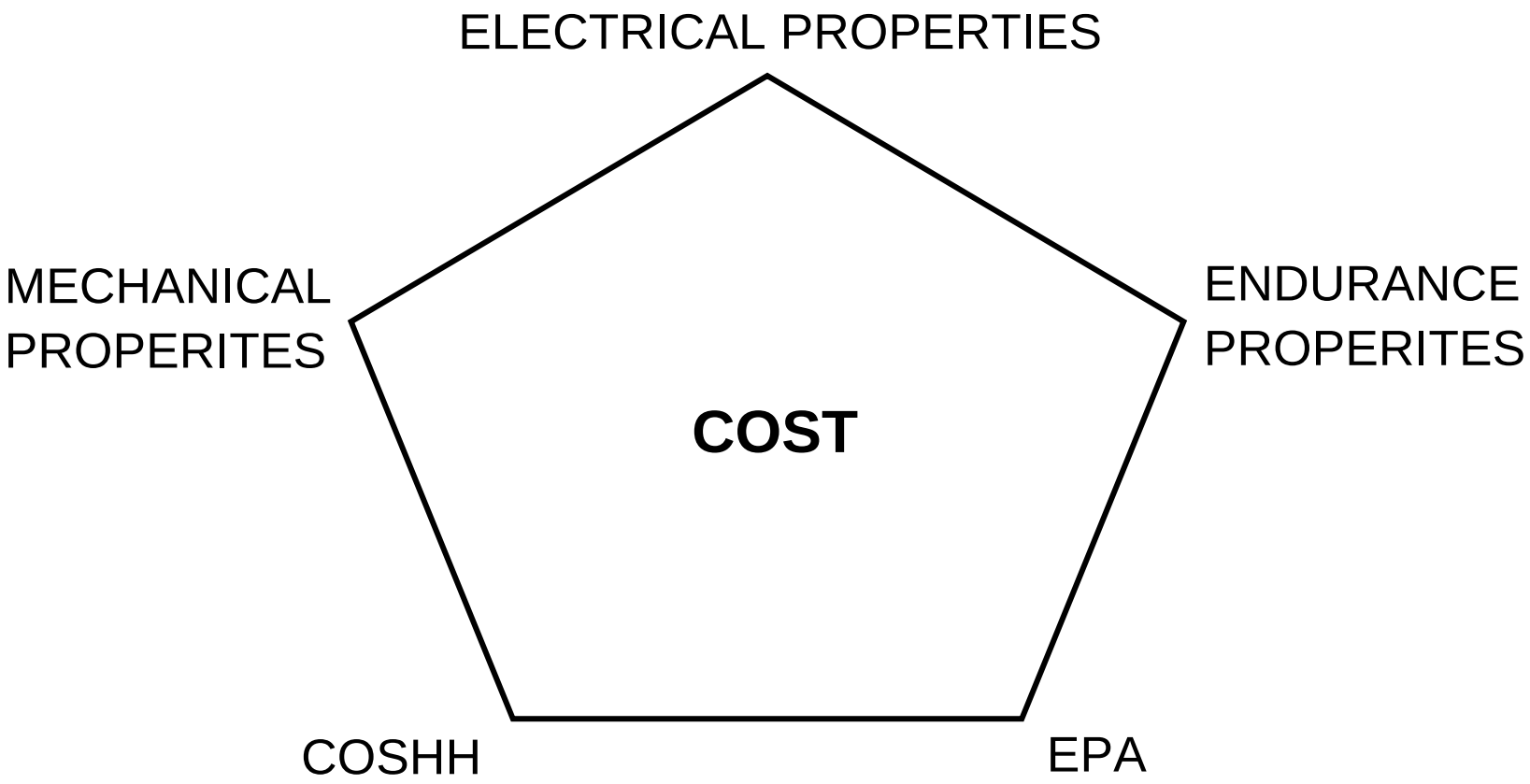
CONSTRAINTS ON A SYSTEM



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Conclusion – Choice of resin?

Challenges of performance criteria, cost, and environmental issues fact the engineers decision.

- What are the performance characteristics of the resin?
- What does the varnish cost?
- What are the costs with disposal of varnish?
- Will I need to change in the future due to environmental legislation?
- Will this varnish suit my process without impacting the air quality?

Thank you for your attention.