Solutions for HEV - Motors

Electrical Insulation Systems (EIS)?

• Wire Enamels (WE)
• Impregnating Resins (IR)
• Core Sheet Varnishes (CSV)

⇒ EIS belongs to BU: DuPont Performance Coatings

Where are we located?

⇒ Our headquarters for business responsibility and R & D are located in Germany and in Austria
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DuPont - Five Growth Platforms

- DuPont Safety & Protection
- DuPont Electronic & Communication Technologies
- DuPont Coatings & Color Technologies
- DuPont Performance Materials
- DuPont Agriculture & Nutrition

Large Opportunities
Strong Capabilities
Market Leadership
DuPont’s Electrical Insulation Systems are available everywhere in the world. We can supply globally and offer local service.
Solutions for HEV - Motors

DuPont Automotive
This is how you know us ...today
Solutions for HEV - Motors

DuPont Automotive
This is how you know us ...today

Materials for Chassis and Structural
Solutions for HEV - Motors

DuPont Automotive

This is how our customers know us ...today

Materials for Under Hood Components

- Engine Systems
- Transmission System
- Driveline Systems

Electrical Insulation Systems for Electrical Motors
- Wire Enamels
- Impregnating Resins
- Core Sheet Varnishes

Solutions for HEV - Motors

Hybrid Electric Vehicle: Unique Systems

- Battery
  - Ni-Me-H system
  - Li-Ion system
  - Ultra-Capacitors

- Inverter / Converter
  - DC-AC Inverter
  - DC-DC Converter

- Electric Motor
  - Engine Starter
  - Drive to Wheel
  - Charge to Battery

- Generator

- ECU
  - Electronic Control Unit for each system

- Gasoline engine

- Planetary gear
Solutions for HEV - Motors

Opportunities for Material Solutions from DuPont

Generator & Electric Motor
- Magnet Wires (Wire Enamels)
- Impregnating materials
- Insulation materials
- High temp. eng. Polymers

Battery
- Ionic liquids, electrolyte, binder
- Membranes
- Housing: Engineering Polymers

Inverter / Converter
- Engineering Polymers for housings, electrical transformer, new cooling system
- Electronic Materials

Electronic Control Unit
- Housing: Eng. Polymers
- Polymeric film for Insulation
- FCM, MCM
Solutions for HEV - Motors

DuPont Materials in a Motor

- Vespel®
- Nomex®
- Crastin® (CR)
- Teflon®
- Crastin® (PBT)
- Vespel® (PI)
- Voltatex®
  Core Sheet Varnish
- Teonex® (PEN)
- Voltron®
  Wire Enamel
- Zytel® (PA)
- Zenite®
- Delrin® (POM)
- Impregnating Resin

Solutions for HEV - Motors

Purpose of **Wire Enamels**

- Primary Insulation of Round or Rectangular Copper or Aluminum Wires
**Solutions for HEV - Motors**

Value for Hyundai Motor Company

⇒ Voltron™ magnet wires for HEV - Motors

- Voltron™ E 3597 is a new generation of magnet wire insulation that solves the problem of premature failures of inverter fed motors
Solutions for HEV - Motors

Voltage vs. Time at the Input of an Inverter Driven Electrical Motor

Voltage at the motor

Corona inception at +/- 850 V
Solutions for HEV - Motors

Benefits when using Voltron™ magnet wire

• outstanding corona resistance
• prevent premature failures caused by partial discharges
• very high V-t Lifetime (more than 1000 hrs @ 2,4 kV)
• superior thermal properties under the influence of ATF – oil
• good flexibility
• high increase of film hardness
• use of nanotechnology (no classical fillers)
Solutions for HEV - Motors

Purpose of Impregnating Resins

• Mechanical Strengthening of the Winding
• Additional Electrical Insulation
• Protection against Chemical and Mechanical Attack
• Improved Heat Transfer
Solutions for HEV - Motors

Value for Hyundai Motor Company
⇒ low emission 1K-Impregnating Resins
E 4011 UV & LP 1006 UV

Comparison of Emissions
1K-Impregnating Resins: styrene-based / low emission systems

Graph shows excellent emission behavior compared to conventional styrene-based products
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Decrease of Bond Strength on Twisted Coils at 155°C after Aging at 260°C

Magnet Wire: SH Therm 210 Grd 1
Impreg. Resin: see legend
Standard: IEC 61033

Twisted Coil: 100 windings/0.315mm/twisted 720°
Curing condition: 4h 150°C

Conditions for impreg.: Twisted Coil 10 min horizontal dipping - 10 min horizontal draining - Curing 4h in horizontal position at 150°C

Conditions for aging:
- Temperature: 155°C
- Time: 70 days

Aging Performance: comparison between conventional systems & new developed products shows excellent Bond Strength
Solutions for HEV - Motors

Value for Hyundai Motor Company
⇒ Herberts® Electrical / UV - Process

State of The Art
Impregnating Technology

What’s so special about Electrical-UV?
- most environmental-friendly impregnating-technology
- amount of resin usage and impregnating quality can be controlled exactly from average to maximum
- draining losses and evaporation losses are minimized
- combined with low emission products and high pre-heat temperatures emissions from 1-3 % only are possible
Solutions for HEV - Motors

Value for Hyundai Motor Company
⇒ Herberts® Electrical / UV - Process
(for Impregnation of Stators)
Solutions for HEV - Motors

Purpose & Users of Core Sheet Varnishes

• **Purpose:**
electrical insulation of each metal sheet to another for construction of magnetizable cores in electrical machines

• **Users:**
Producers of electrical steel and big-sized generators, worldwide

• **VOLTATEX®:**
DuPont brand name for the family of highly sophisticated core sheet varnishes
DuPont has developed the self-bonding varnish VOLTATEX® E 1175W, a waterborne system with excellent insulation and processing characteristics. These advantages make VOLTATEX® E 1175W the ideal insulation system for high performance applications, e.g. advanced HEV- Motors.
Solutions for HEV - Motors

Benefits when using Core Sheet Varnish Voltatex® E 1175W

- Functional self-bonding varnish to hold a stack of electrical steel sheets together and form a solid core
- Exact stack dimensions and flexibility in design
- Homogeneous core stacking and no interlaminar cross-circuit in the stack
- No squeezing effect
- Excellent surface insulation
- High bond strength
- Waterborne system, environment-friendly, innovative varnish systems
Solutions for HEV - Motors

Product Range VOLTATEX®:
The Family of Core Sheet Varnishes

- **VOLTATEX® E 1120:**
  the innovative Titanate based C5 insulation system with high heat resistance as an environmental-friendly alternative to delicate chromium based varnishes (complies with the stringent RoHS standards)

- **VOLTATEX® E 1175W:**
  self-bonding varnish system based on epoxy resins allowing a very efficient fixing technology for core sheet stacks

- **VOLTATEX® E 1151:**
  pigmented and filled core sheet varnishes engineered especially for the advanced generator industry

- **VOLTATEX® E 1153:**
  unfilled systems with excellent punching performance and outstanding resistance against mechanical and chemical influences

=> all VOLTATEX® systems are waterborne systems
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From Electrical Steel To Electrical Machines
yellow → Requirements of Core Sheet Varnishes
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DuPont Performance Coatings
Electrical Insulation Systems

Impregnating Materials
Wire Enamels
Core Sheet Varnishes