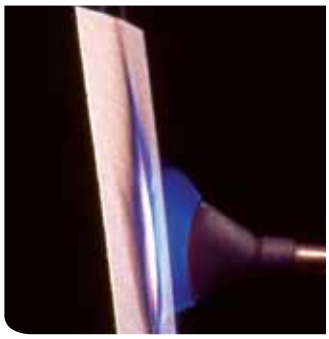
3M Electrical Insulation Solutions:
Flexible Insulations and Tapes

Effective, Efficient

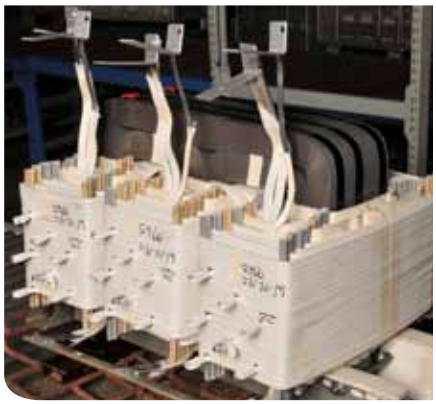
Easy-to-Use Insulation

Contents

As the demands on electrical components increase, 3M offers insulating and protecting products that are performance engineered to meet the most rigorous applications at temperatures ranging from sub-zero to more than 250°C. These state-of-the-art materials have been refined, tested and proven in a wide variety of applications – including use as high-temperature electrical insulation in transformers, motors and generators; and as flame barriers in household appliances. The flexible insulation products described here are those developed by the former Innovative Paper Technologies, LLC, now a part of 3M.



Inorganic paper technology offers:



Voltage Endurance

3M™ Inorganic Insulating Materials retain a high percentage of dielectric strength even after extended exposure to high operating temperatures. They also will exhibit greater voltage endurance under continuous electrical stress than many other electrical insulation materials, helping improve equipment reliability.

Thermal Conductivity

The high thermal conductivity of inorganic papers helps achieve the heat dissipation required in today's high efficiency electrical apparatus, allowing the design of smaller, more cost effective equipment.

Varnish Absorption

The good varnish absorption characteristics of inorganic paper can enhance its already high thermal conductivity, allowing equipment to run cooler, quieter, and last longer.

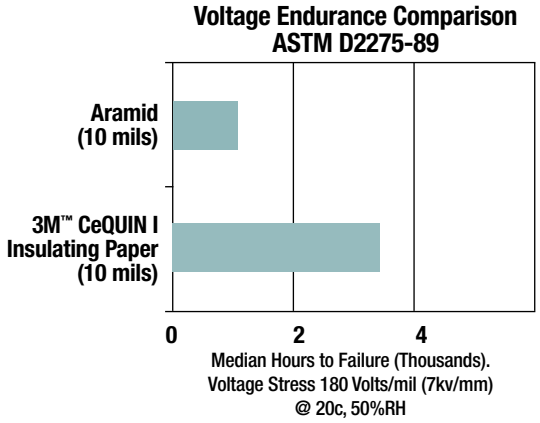
Low Moisture Absorption

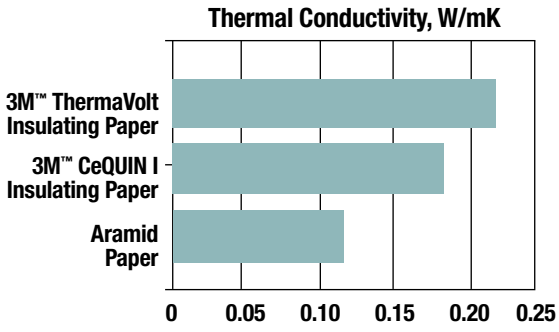
Manufactured with less than 1% moisture content, inorganic papers exhibit low moisture absorption even in humid environments. This gives them dimensional stability and helps reduce the need for extended drying cycles.

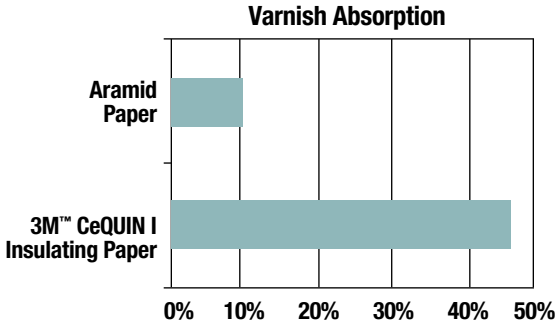
For details, contact your 3M representative or go to www.3m.com/oem.

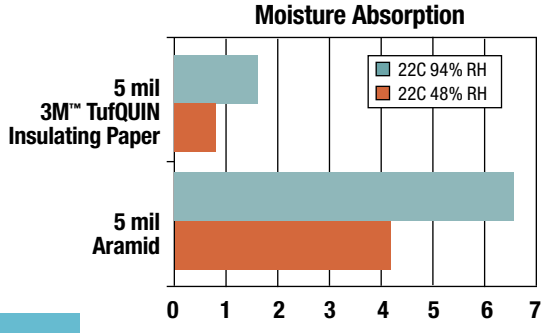
Applications Include

- Ground, phase and interwinding insulation for dry-type transformers
- Slot, phase and wedge insulation for electric motors and generators
- Flame barrier insulation for appliances
- Collars for voice coils used in speakers
- Lens wrap cushioning for eye glass lens production
- Wire and cable wrap
- Specialty paper base for tamper-proof labels
- Layer insulation used in cast coil transformers









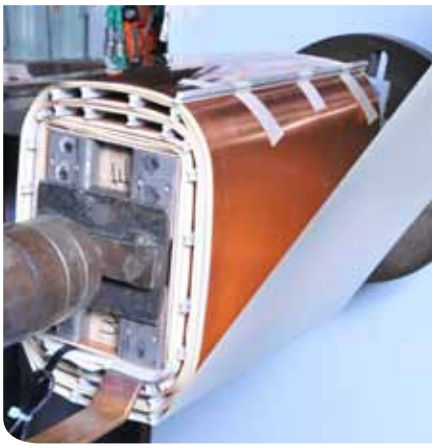
Inorganic and Hybrid Papers

3M™ ThermaVolt AR Electrical Insulation Paper

3M™ ThermaVolt AR (TVAR) Electrical Insulation Paper is a significant advancement in electrical insulation. This proprietary paper combines the long-recognized advantages of inorganic paper with improved mechanical properties. The result is a stable high-temperature insulating paper with excellent retained flexibility. Its toughness and dielectric strength allows for use in single-ply form for a variety of electrical insulation applications that require high-temperature systems up to class 220(R).

3M ThermaVolt Calendared Inorganic Insulating Paper

The high thermal conductivity of ThermaVolt papers helps achieve the heat dissipation required in today's high efficiency electrical apparatus, allowing the design of smaller, more cost effective equipment. It has been designed for use as major ground insulation in electrical insulation systems up to Class 220(R).



Features and Benefits

- UL Systems Recognition through Class 220 (R)
- High Inorganic Content
- Excellent Thermal Conductivity
- Good Dielectric Breakdown Resistance
- Cost effective with improved processability
- Low Moisture Absorption
- Thicknesses: 2 mils (.08mm) to 10 mils (.25mm)
- Good Retained Dielectrics

After 2 weeks aging at 260° C

3M ThermaVolt and ThermaVolt AR Calendared Insulating Papers are inorganic-based papers developed to meet the high performance required for use in high-temperature, dry-type transformers. They offer good dielectric characteristics and thermal conductivity – making them especially suitable for use as interwinding insulation in strip-wound and wire-wound coils.

Applications

High Temperature Electrical Insulation for:
Dry-type transformers, coils and reactors

- Ground Insulation
- Phase Insulation
- Layer Insulation
- Interwinding for foil-wound designs
- Electromagnet Coils

3M™ CeQUIN I and II Inorganic Insulating Paper, Laminates and Boards

Features and Benefits

- UL systems recognition through Class 220(R).
- CSA Component Acceptance: Temperature Class 220.
- Excellent Thermal Conductivity
- Good varnish absorption
- Good retained dielectric at temperatures over 220C
- Low Moisture Absorption
- CeQUIN I Thicknesses: 5 mils (.13mm) to 30 mils (.76mm)
- CeQUIN II Thicknesses: 30 mil (.76mm) to 60 mil (1.52mm)

3M™ CeQUIN Inorganic Insulating Paper is 3M's highest inorganic-content paper; comprised primarily of glass fibers and microfibers, inorganic fillers, and less than 10% organic binder. It is capable of performance at temperature peaks up to 250° C and is a highly flexible paper. This paper has found a wide variety of uses over the years but its main use remains as interwinding insulation for foil wound dry-type transformers.

Applications

High Temperature Electrical Insulation for:
Dry-type transformers, coils and reactors

- Ground/Interwinding Insulation
- Phase Insulation
- Layer Insulation
- Barrier Insulation
- Core Wrap
- End Fill

Electromagnet Layer Insulation
Switchgear Insulation
Spiral and Convolute Tubing

3M™ CeQUIN 3000 Inorganic Insulating Paper

3M Inorganic Insulating Paper CeQUIN 3000 is a modified version of CeQUIN I paper developed to provide high-strength thin papers. By introducing a small percentage of organic fiber reinforcement along with a high-strength binder system, Cequin 3000 papers may be produced in 3-mil and 5-mil thicknesses. It may be laminated with polyester film, or glass fabric to enhance initial dielectric strength or improve mechanical manageability.

3M™ Hybrid Insulating Papers

TufQUIN 110 and TufQUIN 120 Papers

Features and Benefits

- Physically tough
- Maintain dielectric strength under high humidity
- Cost effective
- Excellent stiffness
- High thermal conductivity
- UL® Systems Recognition through Class 200(N)
- CSA Component Acceptance: Temperature Class 200
- TufQUIN 110 -Thicknesses: 2 mils (.05mm) to 10 mils (.25mm)
- TufQUIN 120 -Thicknesses: 7.5 mil (.19mm) to 20 mil (.50mm)

3M TufQUIN 110 Hybrid Insulating Paper

3M TufQUIN 110 Hybrid Insulating Paper is a flexible, conformable paper which has physical toughness in the form of high tensile strength and excellent tear resistance. TufQUIN 110 paper offers good dielectric characteristics and thermal conductivity in conjunction with high temperature performance.

3M TufQUIN 120 Hybrid Insulating Paper

3M TufQUIN 120 Hybrid Insulating Paper is generically the same as TufQUIN 110 paper, with the exception that TufQUIN 120 paper is created through a modified manufacturing process that yields thicker constructions while maintaining conformability.

Applications

Dry-Type Transformers, coils and reactors
• Ground/Interwinding Insulation
• Phase Insulation
• Layer Insulation
• Barrier Insulation
Spiral- and Convolute-wound Tubing
Motors and Generators
• Slot Liner
• Wedge
• Phase Insulation
Wire and Cable Wrap
Switchgear Insulation
Pressure-Sensitive Tapes

TufQUIN paper offers the high-temperature capabilities of inorganic materials combined with the high mechanical strength made possible by the use of organic fiber. They can be combined with polyester film to form a flexible laminate uniquely suited for high-temperature electrical insulation applications.

Non-Woven PPS Paper

3M™ Thermal Shield Modified PPS Non-Woven Insulating Paper (PPS is Polyphenylene Sulfide)

Features and Benefits

- Physically tough
- Cost effective
- Low moisture absorption
- Oil & chemical resistant
- UL® Systems Recognition through Class 220(R)
- Thicknesses: 2 mils (.05mm) to 7 mils (.18mm)
- Available in widths up to 65”

3M™ Thermal Shield PPS Non-Woven Insulating Paper

3M™ Thermal Shield PPS Non-Woven Insulating Paper is designed for use in applications requiring long-term exposure to high temperatures or resistance to chemicals including oils, solvents, and most acids and bases. Thermal Shield paper can be used in a variety of applications without drying. Thermal Shield paper may be laminated to polyester film or resin coated to enhance its performance.

Applications

Dry-Type Transformers, coils and reactors

- Ground/Interwinding Insulation
- Phase Insulation
- Layer Insulation

Oil-Filled transformer insulation
Spiral- and Convolute-wound Tubing
Wire and Cable Wrap
Electromagnetic coils

Laminates using polyester film

Why use a polyester film laminate?

The polyester film component is considered to be mechanical support for the inorganic insulating paper. It is a processing aid to help in the manufacturing process. However, considering the thermal, mechanical, electrical, and UL factors together can be complex.

What are the thermal capabilities of polyester film?

The major concern of most people is the thermal capabilities of polyester film. Polyester film is a component rated as a 130° C material; it will shrink and embrittle when aged at high temperatures. The primary mode of this degradation is oxidation. However, lamination will help slow this process, as will a properly varnished or impregnated unit. As the film slowly oxidizes, it breaks down into its constituent chemicals. These chemicals do not attack other components, such as the magnet wire coating or the varnish, nor does the film carbonize. This "friendly" degradation is one of the reasons that polyethyleneterepthalate (PET) polyester film is so widely used in electrical insulation applications. Others are concerned that it will melt because it is "only a 130º C material." The actual melting point of PET polyester film is over 240º C. Although it will begin to lose mechanical strength at high temperatures, polyester film can withstand short-term thermal excursions if protected from oxidation.

How long have polyester film laminates been used?

From a historical perspective, inorganic papers laminated with polyester film have been used successfully for more than 40 years in Class 220(R) coil applications, ranging from small H.I.D. ballast transformers to medium size dry-type distribution transformers. For example, 3M™ CeQUIN IF Inorganic Insulating Paper Laminate is used as a wire wrap in the manufacture of a 250° C rated appliance wiring material (UL Style 5288/CSA Class 1, Group A/B) for use in high-temperature, severe environments. The acceptance of inorganic insulating paper paper-polyester film laminates for use in these high performance applications speaks for itself.

Types of Laminates available

3M™ Inorganic Insulating Paper Laminates

Features and Benefits

- High temperature capabilities
- Long-term dielectric strength
- Good thermal conductivity
- Low moisture absorption
- Cost effective
  …Combined with the added benefits of polyester film
- Improved cut-through resistance
- Good Stiffness and snap back
- Higher mechanical strength
- Improved resistance to tear
- High initial dielectric strength

UL® AND CSA CERTIFICATION

- UL Systems Recognition from Class 130(B) through Class 220(R)
- CSA Component Acceptance Temperature Class 220 (CeQUIN), Class 200 (TufQUIN)

- **All listed laminates are available in a wide variety of thickness combinations.**

CeQUIN Laminates

3M CeQUIN IF Inorganic Insulating Paper:
This is a two-ply composite of CeQUIN I inorganic paper bonded to polyester film.

3M CeQUIN IFI Inorganic Insulating Paper:
This is a three-ply composite of CeQUIN I paper bonded to both sides of a polyester film.

3M CeQUIN FIF Inorganic Insulating Paper:
This is a three-ply composite of polyester film bonded to both sides of CeQUIN I paper.

3M CeQUIN 30F Inorganic Insulating Paper:
This is a two-ply composite of CeQUIN 3000 inorganic paper bonded to polyester film.

3M CeQUIN 30F30 Inorganic Insulating Paper:
This is a three-ply composite of CeQUIN 3000 paper bonded to both sides of a polyester film.

3M CeQUIN IG, CeQUIN IGI, and CeQUIN GIG Inorganic Insulating Papers:
CeQUIN can also be laminated to glass fabric for extreme high-temperature applications.

In most cases only a thin layer of polyester film is needed to enhance the mechanical strength of the CeQUIN paper during transformer winding applications. An added benefit is the improved initial dielectric strength, making it easier to proof test coils at high voltages prior to varnishing or encapsulation.

3M™ TufQUIN Laminates

3M™ TufQUIN TF Hybrid Insulating Paper:
This is a two-ply composite of TufQUIN 110 Hybrid paper bonded to polyester film.

3M TFT Hybrid Insulating Paper:
This is a three-ply composite of TufQUIN 110 paper bonded to both sides of a polyester film.

For TF and TFT papers, the polyester film provides an excellent dielectric barrier and adds stiffness and snapback characteristics to the composite. Together the two materials form a flexible laminate that is uniquely suited for motor/generator slot liner, wedge and phase insulation applications. The unique properties of TufQUIN paper make automatic insertion a snap.

ThermaVolt Laminates

3M ThermaVolt TvF Calendered Inorganic Insulating Paper:
This is a two-ply composite of ThermaVolt calenderd inorganic paper bonded to polyester film.

3M ThermaVolt TvFTv Calendered Inorganic Insulating Paper:
This is a three-ply composite of ThermaVolt paper bonded to both sides of a polyester film.

3M ThermaVolt FTvF Calendered Inorganic Insulating Paper:
This is a three-ply composite of polyester film bonded to both sides of ThermaVolt paper.

In most cases only a thin layer of polyester film is needed to enhance the mechanical strength of the ThermaVolt paper during transformer winding applications. Higher thickness films also can help to improve stiffness. The improvement in initial dielectric strength helps to more easily proof test coils at high voltages prior to varnishing or encapsulation.

High-Performance Flexible Laminates

3M™ High Performance Flexible Laminates DMD180

Features and Benefits

- Excellent dielectrics
- Physical toughness
- Good thermal conductivity
- Stiffness and snapback
- UL® Systems Recognition for Class 130(B), Class 155(F), Class 180(H)
- CSA Component Acceptance: Temperature Class 180°C

3M™ High-Performance Flexible Laminates DMD180 comprise a family of three-ply laminates of non-woven polyester fiber mat bonded to both sides of polyester film, then over-coated with a high-performance inorganic-filled resin system. This proprietary product is based on the technology developed for the hybrid insulating paper high-temperature product line

The result is a tough, formable motor insulation that will provide the high reliability found in Class 180(H) materials. DMD180 laminates are designed to provide the same physical and handling characteristics that have made standard DMD laminates the material of choice in Class 155(F) motors and generators for more than 30 years.

Applications

Motors and Generators

• Slot Liner
• Wedge
• Phase Insulation

Inorganic Insulating Boards

3M™ CeQUINBORD CGA Inorganic Insulating Board

Features and Benefits

- UL® Systems Recognition through Class 220(R)
- UL® 94-V0 and 94-5VA Flame Rating
- Excellent Thermal Conductivity
- Good varnish absorption
- Good retained dielectric at temperatures over 220°C
- Low Moisture Absorption
- Thicknesses: 48"x 48" (1220mm x 1220mm)
  Thickness from 1/32" (.79mm) to 3/8" (9.5mm)

3M™ CeQUINBORD CGA Inorganic Insulating Board is a high inorganic content board composed primarily of glass fibers and microfibers, inorganic fillers, and less than 10% organic binders. It is capable of long-term performance at temperatures exceeding 250°C. CeQUINBORD CGA board is directly related to 3M™ CeQUIN Inorganic Insulating Paper and exhibits many of the same high-performance capabilities of the products in semi-rigid board form. CeQUINBORD CGA board is easily impregnated and fully compatible with standard varnishes and resins. Since it does not readily absorb moisture, it does not require extended drying time prior to saturation.

Applications

High Temperature Electrical Insulation for:
Dry-Type Transformers
• Spacer Sticks
• Core Tubes
• Barrier Insulation
• Pads
• End Fill
Traction Motors
Motors/Generators
Switchgear
Flame Barrier insulation for:
• Home appliances (washers, dryers)
• Electronic devices (TVs, computers, microwave ovens)
Heat Sinks
Specialty Gaskets

UL Recognition

3M™ High-Performance Flexible Insulations have undergone extensive thermal aging evaluation per UL 1446, "Standard for Systems of Insulating Materials – General." As a result they are UL Recognized for use as major insulation in electrical insulation systems as listed under 3M Innovative Paper Technologies File No. E65007 and may be found on UL's Electrical Insulation Systems Database at http://data.ul.com/systems/. All systems listed on this database are available for use by any electrical apparatus manufacturer by contacting the nearest UL office.

3M High-Performance Flexible Insulations also conform to testing outlined in IEC 61857-1. (Electrical Insulation Systems – Procedure for Thermal Evaluation) which allows the material in the electrical insulation system to be assigned a thermal class according to IEC 60085 (Thermal Evaluation and Designation of Electrical Insulation).

Recommended Usage

Optimum performance of an electrical insulation system is dependent upon many factors including proper choice of materials, acceptable design criteria, and good manufacturing procedures. The composition of Inorganic, Hybrid and PPS Insulating Paper provides for very good resistance to moisture absorption, thereby minimizing the drying time required prior to varnish impregnation or encapsulation. Varnishing is recommended for construction of equipment that may be exposed to the elements. For design purposes, it is recommended that operating electrical stresses in electrical apparatus not exceed 40 V/mil (1.6 kV/mm) in order to minimize the risk of partial discharge.

Special Product Development

3M provides specialty materials which meet precise performance standards for tough applications. 3M engineers are involved in the continuous improvement of existing products, modification of products to meet special demands, and the development of completely new base materials, compounds, coatings and laminates. 3M has a modern plant with paper making and coating/laminating machinery to both modify existing materials and provide full production runs for your evaluation.

Don't feel constrained by the capabilities of today's materials. 3M welcomes the opportunity to work with you in the development of better products to give you a competitive edge.

Other 3M Insulating Products

3M™ Electrical Insulating Tapes

Acetate Cloth: These aesthetically pleasing tapes offer excellent conformability in coil-wrapping applications up to 105° C plus excellent absorption of electrical insulating resins and varnishes.

Composite Film: These combine the high dielectric strength and edge-tear resistance of polyester film and nonwoven polyester mat.

Epoxy Film: These offer solder and puncture resistance, high dielectric strength, conformability and UL recognition for flame retardancy and use at temperatures up to 155° C. Their versatility may help reduce your tape inventory.

Filament-Reinforced: Many of these are designed for applications needing both the dielectric strength of polyester film and the high mechanical strength of glass fibers. They are ideal in low stretch, high tensile and edge-tear resistance. More cost effective than glass cloth tapes, they are excellent for anchoring lead wires to banding coils. A special paper-backed filament tape is available for high-voltage oil-filled distribution transformer use.

Glass Cloth: 3M offers some of the most flexible and conformable glass cloth backings on the market for high temperature resistance and tensile strength. With excellent absorption of resins and varnishes, they are designed for holding and strapping applications up to 200°C.

Non-Woven: Permeable to gas and liquids, the design of this tape allows thorough penetration of varnishes during vacuum impregnation.

Paper: These provide good cushioning, puncture resistance and toughness.

Polyester Film: These are specified for insulating applications requiring a thin, durable tape with high dielectric strength. They can withstand higher temperature conditions than tapes with acetate backing. They also are conformable, exhibit excellent chemical, solvent and moisture resistance and resist cut-through and abrasion.

Polyimide Film: The physical and electrical properties of polyimide remain stable when used in such applications as coils, harnesses and capacitors, that experience extreme temperatures.

3M™ Electrical Insulating Tapes

PTFE Film: These are high-temperature tapes used in applications requiring consistent performance and minimum shrinkage across a wide range of temperatures. They are extremely resistant to chemicals, have high arc resistance and are free of carbonizing materials.

Vinyl: Scotch® Vinyl Electrical Tapes combine the flexibility of a PVC backing with excellent electrical insulating properties, high dielectric strength, and resistance to moisture, UV rays, abrasion, corrosion, alkalies and acids. (Their rubber-based adhesive performs well over a range of temperatures.) Fade-resistant vinyl comes in a range of colors for marking. For primary electrical insulation up to 600 volts, including wire harnessing, television degaussing coils and high-voltage cables.

3M™ Tape Adhesives

Thermosetting Rubber (RT): Thermosetting adhesives have high initial adhesion and electrical purity. When properly thermoset, a rubber-resin adhesive system will cross-link into a three-dimension matrix molecular form designed to provide greater adhesion and bonding, higher solvent resistance and higher heat resistance.

Acrylic (A): Acrylic adhesives are synthetic polymers specifically formulated to resist heat, oxidation, solvents and oils, and exhibit acceptable performance in many applications without a cure cycle.

Silicone (ST): Silicone adhesives require considerably higher temperatures for the thermosetting reaction. Silicone adhesive systems have exceptional heat resistance, are inorganic and, if burned, leave a nonconductive residue.

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Important Notice

All statements, technical information, and recommendations related to 3M's products are based on information believed to be reliable, but the accuracy or completeness is not guaranteed. Before using this product, you must evaluate it and determine if it is suitable for your intended application. You assume all risks and liability associated with such use. Any statements related to the product which are not contained in 3M's current publications, or any contrary statements contained on your purchase order shall have no force or effect unless expressly agreed upon, in writing, by an authorized officer of 3M.

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