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Tough, reliable protection

3M™ Scotchcast™ OEM Resins

Interactive Product Selection Guide

3M™ Scotchcast™ Resins for Original Equipment Manufacturers

3M™ Scotchcast™ Electrical Liquid Resins are 100-percent-solid, thermosetting, electrical-grade insulating resins. Classified chemically as either epoxies or polyurethanes, the product line includes two-part epoxy liquids and two-part polyurethane liquids. The unique electrical and physical properties make them ideal for insulating and protecting electrical and electronic parts and assemblies. Their physical features also make them suitable for nonelectrical, general-use applications, such as adhesives and sealants.

3M Scotchcast Powder Resins are a series of one-part, 100-percent-solid electrical-grade systems offering fast curing, excellent thermal and mechanical shock resistance, significant cut-through resistance, high adhesion, excellent chemical and moisture resistance, high-to-low flow characteristics and excellent electrostatic coating capability.

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3M™ Scotchcast™ Electrical Liquid Resins

3M Scotchcast Electrical Liquid Resins are a two-part, 100-percent-solid system offering:

- Easy mixing ratios
- Moderate to long pot life
- Low exotherm
- High adhesion
- Good to excellent electrical properties
- Range of flexibility and viscosity

The basic Scotchcast electrical liquid resin systems include flexible, semiflexible and rigid room-temperature-curing and oven-curing resins, some of which are then modified to create filled and thixotropic versions.

Resins are available to meet temperature, class, color and special performance needs. All Scotchcast electrical liquid resins are formulated and produced for convenient and reliable use. Simple mixing ratios and preproportioned packaging allow for easy handling and mixing, and reduce errors on the production line. Scotchcast electrical liquid resins contain no nonylphenol.

Selection Process

The Scotchcast electrical liquid resin most likely to succeed in an application can be selected through a process of elimination. Simply answer four basic questions in conjunction with the flow chart on page 6. The application questions are:

- Room cure or oven cure?
- Filler?
- Degree of flexibility?
- Temperature class?

The following sections provide some additional information that may be used to determine the answers to the above four basic questions.

Selection Process

Room cure or oven cure?

In answering this question, consider:

- **The availability of ovens.**
If curing ovens are not available or if the addition of ovens cannot be justified in your production line, a room-temperature curing resin is typically recommended.
- **The application process (i.e., dipping, potting, casting, impregnation, bonding).**
One of the advantages of a production process in which curing ovens are available is that oven cure resins can be produced. These are typically more versatile than room cure resins because they have long pot lives and short cure times plus their viscosities can be lowered by warming.
- **The number of units to be processed.**
Oven-cured resins are often used in high-volume applications because of increased productivity as a result of faster cure cycles.
- **The mass of resin to be used per unit.**
Room-curing resins rely heavily on the heat generated from their reaction for completion of cure. In a small mass, this heat dissipates quickly through the resin to the surrounding atmosphere so the center does not become too hot. In larger masses, however, the resin might act as a heat insulator and cause the interior temperature to rise rapidly. If uncontrolled, this rise in temperature could exceed the maximum temperature which some components can tolerate. A high exotherm could also cause the resin to crack or char. If a large mass of a room-temperature curing resin must be used, the exotherm problem can be overcome by curing the mass in layers and allowing each layer to cool before casting the next.
- **Rate of cure.**
To obtain the fastest cure, small masses of room temperature curing products can be oven cured.

Filler?

The handling and physical properties of the resin are important in answering this question. Consider the following:

- **Unfilled** systems are used in applications where very low viscosity is a prerequisite; for example, impregnating small or tightly wound coils and filling small voids.
- **Filled** systems are used in applications where increased viscosity, reduced shrinkage, lower exotherm, increased thermal shock resistance, increased thermal conductivity or flame retardancy are needed. Adding a filler always increases viscosity. If one or more of the properties cited are necessary but increased viscosity is not desirable, the viscosity increase can be nullified by warming the filled resin.
- A **thixotropic** resin system is like a gel at rest but takes on the properties of a fluid when agitated. These systems are used in applications where “nonflow” is required, such as wet winding or encapsulation by dipping.
- A **paste** is an extremely high viscosity resin normally applied by spatula, caulking, buttering or troweling.

Degree of flexibility?

To answer this question, consider:

Are stress factors important?
The flexible and semiflexible resin systems exert the least stress on components.

- Will the component be subjected to thermal or mechanical shock? If so, choose a flexible or semiflexible resin.
- To what type of atmosphere will the component be exposed? Rigid epoxies, followed by room-curing epoxies, are usually the most resistant to solvents, chemicals, fuels and radiation.
- What physical property requirements must the resin meet? Rigid systems possess the highest heat-distortion temperature and best physical properties.

Temperature Class?

A resin rated in a specific temperature class is deemed capable of operating continuously at that temperature. The Association of Industrial Electrical Engineers (AIEE Standard Number 1) denotes some of these temperature class ratings:

Class O = 90°C (194°F)
Class A = 105°C (221°F)
Class B = 130°C (266°F)
Class F = 155°C (311°F)
Class H = 180°C (356°F)

Selection process for electrical liquid resins continues on next page >>>

Application Considerations

In addition to the four basic questions on previous page, also consider the following factors:

Does the product meet the handling, electrical and physical property requirements of the application?

What specifications must the resin meet?

Does the selected product satisfy these requirements? Specifications are often of major importance, despite the fact that their consideration may not always indicate the best product for the application. Nevertheless, they must either be met or modified.

What problems have existed with other methods or products that have been used or evaluated?

Does the selected resin have the right clarity or color?

Clear, amber, cream and tan resin systems can be augmented with pigments. The user is responsible for determining if pigmentation affects the properties important to the application. These guidelines may be helpful in making that determination:

- Only predispersed, electrical grade pigmentation systems should be evaluated
- The amount of pigmentation system added should be kept at an absolute minimum (less than two percent)
- The pigmented product should be tested for conformance to all application requirements before actual full-scale use

Is the viscosity of the resin appropriate to the needs of the application?

Viscosity is a measure of the resistance of a liquid to shear forces. This property is important for handling purposes, and in cases where a specific range or type of viscosity may be necessary to meet the needs of the application, e.g., low viscosity to impregnate tightly wound or small diameter windings, or high viscosity for dipping applications. The most common means of viscosity measurement is Brookfield viscosity, reported in centipoise. The table beginning on page 7 shows the wide viscosity range of 3M Scotchcast Electrical Liquid Resins.

Selection Guide

Step 1: Select Type of Resin Cure Needed		Step 2: Select Degree of Flexibility Needed	Step 3: Select Temperature Class Required	Step 4: Select Appropriate 3M™ Resin
Room Cure Resins	**Room Cure Unfilled Resins** Lower Viscosity Better Impregnation	Rigid	Class B	5N
		Semiflexible	Class B	8N, 208N
		Flexible	Class B	226
		Flexible (re-enterable)	Class 0	2123
	Room Cure Filled Resins Medium Viscosity Higher Thermal Conductivity Better Dimensional Stability	Semiflexible	Class B	9N
		Flexible	Class O	2131
	Room Cure Thixotropic Resins Highly Filled Troweling, Buttering Applications	Semiflexible	Class B	10N, 210N
Oven Cure Resins	**Oven Cure Unfilled Resins** Lower Viscosity Better Impregnation	Rigid	Class F	250
			Class B	3
		Semiflexible	Class F	280
			Class B	235
	Oven Cure Filled Resins Medium Viscosity Higher Thermal Conductivity Better Dimensional Stability	Rigid	Class F	251
		Semiflexible	Class F	281, MR283
			Class B	241, 255
	Oven Cure Thixotropic Resins Highly Filled Dipping, Buttering Applications	Rigid	Class F	252
		Semiflexible	Class F	282
			Class B	253

Typical Property Data

Room Cures

Polymer Cure/ Cured Form/ Filler/Color	Temperature Class[1]	3M™ Electrical Liquid Resin Product Number	Description	Mixing Ratio A/B	Viscosity[2] at 23°C (73°F) (Centipoise)	Cure Schedules[3] (Temp/Time)	Gel Time[4]
Polyurethane Room-Temperature Flexible Unfilled Black	B	**226**	This is a rubbery, castor-based, repairable polyurethane that has very low viscosity and excellent hydrolytic stability (meets MIL-I-16923G and naval avionics reversion requirements). Its low volatility at room temperature helps minimize potential toxicity. Data Sheet Safety Data Sheet	Wt 2:5 Vol (%) 23.6:75.4	A=190 B=750 Mixed=650	23°C (73°F) 72 hrs. 67°C (152°F) 6 hrs.	15 min. at 60°C (140°F)
Epoxy Room-Temperature Rigid Unfilled Clear Amber	B	**5N**	This is a general purpose, very low viscosity, chemical and moisture-resistant, transparent epoxy with a long pot life and low exotherm. No nonylphenol. Data Sheet Safety Data Sheet	Wt 2:1 Vol (%) 63.5:36.5	A = 12,500 B = 100 Mixed = 3,000	23°C (73°F) 24-48 hrs. 60°C (140°F) 1 hr. 95°C (203°F) 1/2 hr.	18 min. at 60°C (140°F)
Epoxy Room-Temperature Semiflexible Unfilled Clear Amber Reddish Brown	B	**8N** / **208N**	This is a clear, general purpose electrical resin. 3M resin 208 is red and supplied in kit form for use as a motor repair resin. Both semiflexible epoxies exhibit low stress, low exotherm, good fuel and oil resistance, long pot life, and permanent mechanical and thermal shock resistance. No nonylphenol. Data Sheet-8N Safety Data Sheet-8N Data Sheet-208N Safety Data Sheet-208N	Wt 1:1 Vol (%) 46:54	A = 12,500 B = 4,000 Mixed = 7,000	23°C (73°F) 24-48 hrs. 60°C (140°F) 2 hrs. 95°C (203°F) 1 hr.	30 min. at 60°C (140°F)
Epoxy Room-Temperature Semiflexible Filled Reddish Brown	B	**9N**	This medium viscosity, filled version of 3M resin 8N possesses all the good features of 3M resin 8N plus very low exotherm, less shrinkage (even lower stress), improved thermal shock resistance and higher thermal conductivity. Self extinguishing. Tested to MIL-I-16923G. No nonylphenol. Data Sheet Safety Data Sheet	Wt 1:1 Vol (%) 47:53	A = 90,000 B = 20,000 Mixed = 28,000	23°C (73°F) 24-48 hrs. 60°C (140°F) 2 hrs. 95°C (203°F) 1 hr.	28 min. at 60°C (140°F)
Epoxy Room-Temperature Semiflexible Filled (paste) Reddish Brown	B	**10N** / **210N**	Both of these products have a heavy paste (peanut butter) consistency. 3M resin 10N is for general use. 3M resin 210N is supplied in kit for use primarily as a motor repair resin. They are versions of 3M resin 9 and exhibit many of its good features. Self extinguishing. No nonylphenol. Data Sheet-10N Safety Data Sheet-10N Data Sheet-210N Safety Data Sheet-210N	Wt 1:1 Vol (%) 47:53	A = paste B = paste Mixed = paste	23°C (73°F) 24-48 hrs. 60°C (140°F) 2 hrs. 95°C (203°F) 1 hr.	30 min. at 60°C (140°F)

Typical property data for room cures continues on next page >>>

Test methods

1 AIEE standard.
2 Brookfield Viscometer
3 The cure times do not take into consideration the time necessary for the part and resin to reach the cure temperature. The user must determine this time and add it to the cure time at temperature.
4 3M Test Method, using Sunshine Gel Timer

Typical Property Data

Room Cures (continued from previous page)

3M™ Electrical Liquid Resin Product Number	Hardness[5]	Specific Gravity[6]/ Density (Cured)	Thermal Shock Resistance[7] (Passes 10 Cycles at Specified Temperature Range and Insert Size)	Linear Thermal Expansion[8] (Length/Unit Length/°C)	Tensile Strength[9] (psi)	Thermal Conductivity[8] (W/Mk)[14]	Moisture Absorption[10, 13] (% Wt Gain)	Dielectric Strength[11] (Volts Per Mil. 1/8 Inch Sample)	Volume Resistivity[12] (Ohm-Cm at 23°C)
226	75 Shore A	1.06/8.85 lb/gal	130°C to -55°C 1/4 in. (6.35mm) insert	23×10^{-5}	68.9 Kg/cm^2	0.20	120 days @ 71°C and 95% RH Weight gain = 0.45%	420 V/mil	10^{13}
5N	15 Barcol	1.12/9.35 lb/gal		17.7×10^{-5}	562 Kg/cm^2	0.18	240 hours @ 96% RH Weight gain = 0.5%	325 V/mil	10^{14}
8N **208N**	68 Shore D	1.12/9.35 lb/gal	130°C to -55°C 1/8 in. (3.175 mm) insert	15×10^{-5}	120 Kg/cm^2	0.18	240 hours @ 96% RH Weight gain = 1.6%	325 V/mil	10^{13}
9N	70 Shore D	1.42/11.85 lb/gal	130°C to -55°C 1/4 in. (6.35 mm) insert	13×10^{-5}	155 Kg/cm^2	0.31	240 hours @ 96% RH Weight gain = 0.8%	350 V/mil	10^{13}
10N **210N**	70 Shore D	1.55/12.94 lb/gal	130°C to -55°C 1/4 in. (6.35 mm) insert	8.6×10^{-5}	105 Kg/cm^2	0.34	240 hours @ 96% RH Weight gain = 0.44%	350 V/mil	10^{12}

Typical property data for room cures continues on next page >>>

Test methods

5 Shore A = Immediate per ASTM D 2240
Shore D = Immediate per ASTM D2240
Barcol = Immediate per Barcol Hardness Tester
6 ASTM D792
7 Olyphant Inserts = 3M Test Method
(1/8 inch = 3,175 mm, 1/4 inch = 6,35 mm)
8 ASTM D696
9 ASTM D638
10 ASTM D570, 240 hours @ 96% R.H.
11 ASTM D149
12 ASTM D257
13 ASTM D570-81, 24 hour immersion @ 23°C

Typical Property Data

Room Cures (continued from previous page)

Polymer Cure/ Cured Form/ Filler/Color	Temperature Class[1]	3M™ Electrical Liquid Resin Product Number	Description	Mixing Ratio A/B	Viscosity[2] at 25°C (77°F) (Centipoise)	Cure Schedules[3] (Temp/Time)	Gel Time[4] (Minutes)
Polybutadiene Room-Temperature Soft, reenterable Unfilled Translucent Amber	0	**2123**	3M resin 2123 is a soft, two-part polybutadiene resin encapsulant designed specifically for re-enterable protection. It is formulated for virtually every electrical application requiring a soft, re-enterable resin with good handling and performance characteristics up to 1000 Volts. Data Sheet Safety Data Sheet	Wt 1:1 Vol (%) 48:52	A= 350-750* B= 700-1400*	21°C (70°F) 24 hrs.	62 min.
Polyurethane Room-Temperature Flexible Filled Black	0	**2131**	3M Scotchcast Flame-Retardant Compound 2131 is a two-part polyurethane resin designed to withstand rugged conditions for operating up to 1000 Volts. Data Sheet Safety Data Sheet	Wt 1:2 Vol (%) 37:63	A= 600-1100* B= 400-10000*	0°C (32°F) 24 hrs. 10°C (50°F) 24-30 hrs. 21°C (70°F) 16-24 hrs.	17 min.

Typical property data for room cures continues on next page >>>

Oven Cures – Unfilled Resins

Polymer Cure/ Cured Form/ Filler/Color	Temperature Class[1]	3M Electrical Liquid Resin Product Number	Description	Mixing Ratio A/B	Viscosity[2] @25°C (77°F) (Centipoise)	Cure Schedules[3] (Temp/Time)	Gel Time[4] (Minutes)
Epoxy Oven-Temperature Rigid Unfilled Brown	F	**250**	The distinguishing features of this product are its high-temperature stability, good electrical and physical properties, and low viscosity. It is used where adhesion, mechanical strength and good electricals at high temperatures are needed. Data Sheet Safety Data Sheet	Wt 1:1 Vol (%) 50:50	A=13,000 B=130 Mixed=1,800	75°C (167°F) 15-20 hrs. 95°C (203°F) 6-8 hrs. 120°C (248°F) 2-3 hrs.	17 min.
Epoxy Oven-Temperature Rigid Unfilled Clear Amber	B	**3**	This product has very low viscosity that allows for complete impregnation of small voids. It is also characterized by good electricals, outstanding physical stability and superior moisture resistance. Data Sheet Safety Data Sheet	Wt 2:3 Vol (%) 37:63	A = 12,500 B = 400 Mixed = 1,600	77°C (167°F) 12-16 hrs. 95°C (203°F) 6-8 hrs. 120°C (248°F) 1-2 hrs.	21 min.
Epoxy Oven-Temperature Semiflexible Unfilled Clear Amber	F	**280**	This product is characterized by its high-temperature stability, superior electrical properties and thermal shock resistance. Data Sheet Safety Data Sheet	Wt 2:3 Vol (%) 37:63	A = 12,500 B = 2,500 Mixed = 4,000	75°C (167°F) 24 hrs. 95°C (203°F) 6-8 hrs. 120°C (248°F) 2-3 hrs.	20 min.
Epoxy Oven-Temperature Semiflexible Unfilled Reddish-Brown	B	**235**	Permanent semiflexibility, thermal shock and impact resistance, stable properties, good electricals and adhesion are features of 3M resin 235. Very low viscosity and good wetting ability allow for complete impregnation of small voids. Data Sheet Safety Data Sheet	Wt 1:2 Vol (%) 31:69	A = 13,000 B = 1,000 Mixed = 1,500	75°C (167°F) 15-20 hrs. 95°C (203°F) 6-8 hrs. 120°C (248°F) 2-3 hrs.	18 min.

Typical property data for oven cures (unfilled resins) continues on next page >>>

Typical Property Data

Room Cures (continued from previous page)

3M™ Electrical Liquid Resin Product Number	Hardness[5]	Specific Gravity[6]/ Density (Cured)	Renterable and Flame Retardant	Max Exotherm (3M Test Method-67), 100 grams	Tensile Strength[9] (psi)	Thermal Conductivity[8] (W/Mk)[14]	Moisture Absorption[10, 13] (% Wt Gain)	Dielectric Strength[11] (Volts Per Mil. 1/8 in. Sample)	Insulation Resistance
2123	0 Shore A	0.53 oz./in.^{3}		6°F (3°C) rise	0.75 Kg/cm^2		24 hours @ 23°C, immersion Weight gain = 0.2%	240 V/mil	4×10^{11} ohms (MS 17000, Section 1182)
2131	82 Shore A	0.69 oz./in.^{3}		147°F (64°C) rise	73 Kg/cm^2		168 hours @ 100°C, immersion Weight gain = 4.9%	343 V/mil	

Oven Cures – Unfilled Resins (continued from previous page)

3M Electrical Liquid Resin Product Number	Hardness[5]	Specific Gravity[6]/ Density (Cured)	Thermal Shock Resistance[7] (Passes 10 Cycles at Specified Temperature Range and Insert Size)	Linear Thermal Expansion[8] (Length/Unit Length/°C)	Tensile Strength[9] (psi)	Thermal Conductivity[8] (W/Mk)[14]	Moisture Absorption[10, 13] (% Wt Gain)	Dielectric Strength[11] (Volts Per Mil. 1/8 Inch Sample)	Volume Resistivity[12] (Ohm-Cm at 23°C)
250	25 Barcol	1.06/8.85 lb/gal		6.5×10^{-6}	548 Kg/cm^2	0.15	240 hours @ 96% RH Weight gain = 0.30%	325 V/mil	10^{15}
3	80 Shore D	1.12/9.35 lb/gal		20×10^{-5}	310 Kg/cm^2	0.17	240 hours @ 96% RH Weight gain = 0.5%	300 V/mil	10^{15}
280	65 Shore D	1.08/9.01 lb/gal	130°C to -65°C 1/8 in. insert Passes Mil-I-16923E	21×10^{-5}	310 Kg/cm^2	0.22	240 hours @ 96% RH Weight gain = 0.5%	375 V/mil	10^{15}
235	55 Shore D	1.10/9.18 lb/gal	130°C to -55°C 1/8 in. insert	16×10^{-5}	91 Kg/cm^2	0.17	240 hours @ 96% RH Weight gain = 0.92%	325 V/mil	10^{15}

3M™ Scotchcast™ Electrical Liquid Resins

Typical Property Data

Oven Cures – Filled Resins

Polymer Cure/ Cured Form/ Filler/Color	Temp. Class[1]	3M™ Electrical Liquid Resin Product Number	Description	Mixing Ratio A/B	Viscosity[2] at 25°C (77°F) (Centipoise)	Cure Schedules[3] (Temp/Time)	Gel Time[4] (Minutes)
Epoxy Oven-Temperature Rigid Filled Brown	F	**251**	This medium-viscosity, filled version of 3M resin 250 offers many of the same advantages plus lower shrinkage, improved mechanical and thermal shock resistance and higher thermal conductivity. It meets the requirements of MIL-I-16923G. Self extinguishing. Data Sheet Safety Data Sheet	Wt 1:1 Vol (%) 50:50	A=175,000 B=10,000 Mixed=19,000	75°C (167°F) 15-20 hrs. 95°C (203°F) 6-8 hrs. 120°C (248°F) 2-3 hrs.	20 min.
Epoxy Oven-Temperature Semiflexible Filled Off-White Thixotropic	B	**255**	3M resin 255 meets flame retardancy requirements of Fed. Std. 406, Method 2023 and meets the requirements of MIL-I-16923G when postcured for 16 hours at 121°C. It also offers excellent thermal and mechanical shock resistance. Self extinguishing. Data Sheet Safety Data Sheet	Wt 2:3 Vol (%) 39:61	A = Thixotropic B = Thixotropic Mixed = Thixotropic	95°C (203°F) 12-16 hrs. 120°C (248°F) 2-3 hrs.	23 min.
Epoxy Oven-Temperature Semiflexible Filled Cream	F	**281**	This filled version of 3M resin 280 offers many of the key features of 3M resin 280 plus lower shrinkage, improved thermal and mechanical shock resistance, plus high thermal conductivity. Data Sheet Safety Data Sheet	Wt 2:3 Vol (%) 37:63	A = 320,000 B = 38,000 Mixed = 75,000	120°C (248°F) 2- hrs.	21 min.
Epoxy Oven-Temperature Semiflexible Filled Reddish-Brown	B	**241**	This filled version of 3M resin 235 offers many of the key features of 3M resin 235 plus lower shrinkage, improved thermal and mechanical shock resistance, and increased thermal conductivity. Self extinguishing. Data Sheet Safety Data Sheet	Wt 1:2 Vol (%) 31:69	A = 175,000 B = 9,000 Mixed = 15,000	75°C (167°F) 15-20 hrs. 95°C (203°F) 6-8 hrs. 120°C (248°F) 2-3 hrs.	22 min.
Epoxy Oven-Temperature Rigid Filled Thixotropic Reddish-Brown	F	**252**	3M resin 252 is a thixotropic version of 3M resin 251 and offers many of the same advantages. Its thixotropic nature renders it useful in dipping, brushing or troweling applications where resistance to running or sagging is a requirement. Data Sheet Safety Data Sheet	Wt 1:1 Vol (%) 30:70	A=Thixotropic B=Thixotropic Mixed= Thixotropic	95°C (203°F) 12-16 hrs.	23 min.
Epoxy Oven-Temperature Semiflexible Filled Thixotropic Cream	B	**282**	3M resin 282 is a thixotropic version of 3M resin 281 offering many of the same advantages. It is also used in dipping, brushing or troweling applications where resistance to running or sagging is a requirement. Self extinguishing. Data Sheet Safety Data Sheet	Wt 2:3 Vol (%) 37:63	A=Thixotropic B=Thixotropic Mixed= Thixotropic	75°C (167°F) 15-20 hrs. 95°C (203°F) 6-8 hrs. 120°C (248°F) 2-3 hrs.	23 min.
Epoxy Oven-Temperature Semiflexible Filled Thixotropic Reddish-Brown	F	**253**	This product offers many of the advantages of 3M resins 241 and 243. Its thixotropic nature renders it useful in dipping, brushing or troweling applications where resistance to running or sagging is a requirement. Data Sheet Safety Data Sheet	Wt 1:2 Vol (%) 30:70	A=Thixotropic B=Thixotropic Mixed= Thixotropic	95°C (203°F) 12-16 hrs. 120°C (248°F) 2-3 hrs.	23 min.
Primer	B	**5136N**	A one-part, solvent-based system specifically designed to help improve the adhesion of 3M's polyurethane resins to soft substrates such as neoprene, vinyl, polyurethanes, rubbers and semiflexible epoxies. Data Sheet Safety Data Sheet				

Typical property data for oven cure (filled resins) continues on next page >>>

3M™ Scotchcast™ Electrical Liquid Resins

Typical Property Data

Oven Cures – Filled Resins (continued from previous page)

3M™ Electrical Liquid Resin Product Number	Hardness[5]	Specific Gravity[6]/ Density (Cured)	Thermal Shock Resistance[7] (Passes 10 Cycles At Specified Temperature Range And Insert Size)	Linear Thermal Expansion[8] (Length/Unit Length/°C)	Tensile Strength[9] (psi)	Thermal Conductivity[9] (W/Mk)[14]	Moisture Absorption[10,13] (% Wt Gain)	Dielectric Strength[11] (Volts Per Mil. 1/8 Inch Sample)	Volume Resistivity[12] (Ohm-Cm at 23°C)
251	40 Barcol	1.50/12.52 lb/gal	Passes MIL-I-16923G (105°C to -55°C)	5×10^{-5}	371 Kg/cm²	0.33	240 hours @ 96% RH Weight gain = 0.25	425 V/mil	10^{15}
255	72 Shore D	1.56/13.02 lb/gal	130°C to -55°C 1/4 in. insert	15×10^{-5}	105.5 Kg/cm²	0.19	240 hours @ 96% RH Weight gain = 0.45%	375 V/mil	10^{15}
281	65 Shore D	1.43/11.93 lb/gal	130°C to -65°C 1/4 in. insert	15×10^{-5}	147 Kg/cm²	0.50	240 hours @ 96% RH Weight gain = 0.32%	375 V/mil	10^{15}
241	65 Shore D	1.42/11.85 lb/gal	130°C to -55°C 1/4 in. insert	13.6×10^{-5}	91 Kg/cm²	0.33	240 hours @ 96% RH Weight gain = 0.60%	375 V/mil	10^{15}
252	45 Barcol	1.51/12.60 lb/gal	Passes MIL-I-16923G (105°C to -55°C)	4×10^{-5}	421 Kg/cm²	0.29	240 hours @ 96% Weight gain = 0.35%	325 V/mil	10^{14}
282	65 Shore D	1.43/11.93 lb/gal	130°C to -65°C 1/4 in. insert	15×10^{-5}	147 Kg/cm²	0.50	240 hours @ 96% Weight gain = 0.32%	375 V/mil	10^{15}
253	65 Shore D	1.50/12.52 lb/gal	130°C to -55°C 1/4 in. insert	12.6×10^{-5}	91 Kg/cm²	0.33	240 hours @ 96% Weight gain = 0.60%	375 V/mil	10^{15}
5136N									

3M™ Scotchcast™ Powder Resins

Powder resin selection depends primarily on the method of application available.
The four most commonly used methods of applying powder resins are:

- Fluid bed dip
- Venturi spray
- Electrostatic spray
- Electrostatic fluid bed

Selection Process

The best way to select the proper 3M Scotchcast Powder Resin is to consider the needs of the application and the proposed application method.

Application

Successful coating with powder resins is accomplished in four basic steps:

Step 1

Clean the part

One or more processes may be necessary to complete this step: Mechanical removal of rust, dirt, oxide and other contaminant. Common methods include media

Step 2

Preheat the part

Preheating may be omitted if parts are to be coated electrostatically at room temperature, in which case they must be thoroughly dried before coating to prevent outgassing. Forced air ovens, induction heating, radiant heating and resistance heating are four common methods used to preheat parts, cure the resin or both.

Step 3

Coat the part

- **Preheated parts**
  When applied to preheated parts, powder particles melt, flow together, fuse and then cure. When dipping or spraying, the coating thickness depends on the temperature of the part, the duration of the dip/spray, and the melt rate and melt viscosity of the powder. If the powder is applied electrostatically to a preheated part, coating thickness depends on the temperature of the part, the duration of the powder application, the voltage applied to the powder, the chargeability of the powder and the melt rate of the powder.
- **Unheated parts**
  When unheated parts are coated electrostatically, the charged powder resin particles cling to the grounded part. The coating thickness depends on the duration of the powder application, the voltage applied to the powder and the powder's chargeability.

Step 4

Cure the resin

When large, preheated parts are coated, the mass of the part may hold the heat necessary to cure the resin fully without postcuring. However, smaller parts may lose so much heat during coating that they require a postcure to obtain full cure. The time/temperature relationships necessary to obtain full cure are given in the chart on page 16 and on individual product information sheets. These time/temperature relationships do not include the time necessary to heat or reheat the part to the curing temperature. The user must make this determination and start the time cycle when the temperature is reached.

UL Insulation Systems

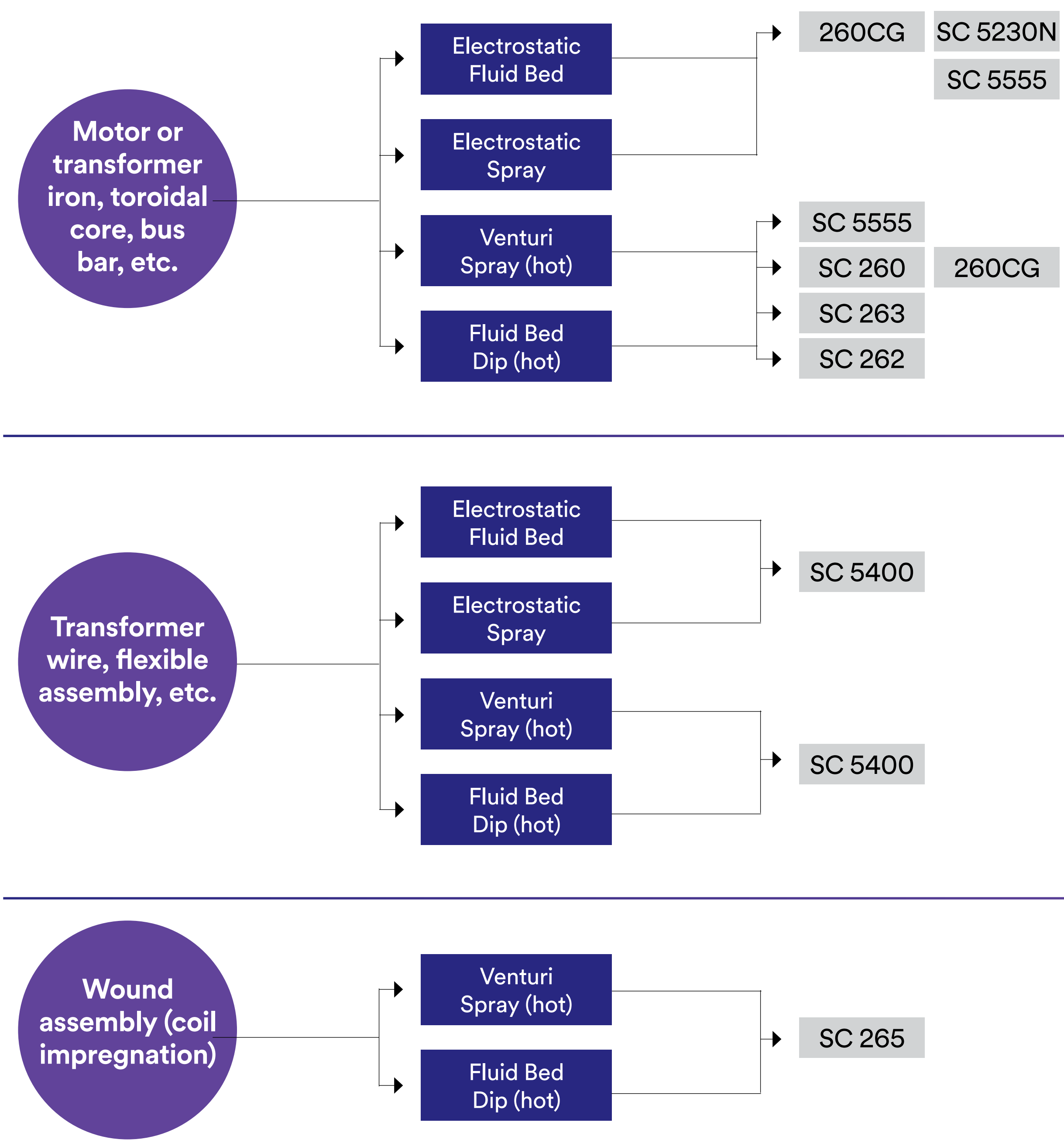
Insulation systems established per UL 1446 and IEC 85 requirements are available for various 3M Scotchcast Resins up to class H (180°C). The major system components include Scotchcast resin as integral ground insulation, magnet wire, interlayer insulation and molding material. "minor" components such as 3M Electrical Tapes, sheet insulation, tie cords, lead wires, varnish, etc. have been added, making the 3M Electrical Insulation Systems ideal for most applications. (If these powder resins do not meet your requirements, consider 3M Flexible Insulations products as an alternative.) The Systems are recognized in UL file E163090 (OBJS2). Contact Technical Service for more details. Many Scotchcast powder resins are also recognized by UL as component insulation per UL 746B. These are listed under UL files E35075 (QMFZ2) and E309208 (OBOR2).

Selection Guide - What component needs to be insulated?

Step 1: Define what needs to be coated

Step 2: Determine the coating application method

Step 3: Select the 3M™ Powder Resin that best fits the needs



Selection Guide - What component needs to be insulated? (continued from previous page)

Step 1:
Define what needs to be coated

What is it that needs electrically insulated?

- Motor stator or armature core?
- Transformer wire? Coiled assembly?

3M offers a number of epoxy powder coatings suitable for use on a variety of applications.

Step 2:
Determine the coating application method

How large or small is the component?

Are there complex, hard-to-reach areas that need to be insulated?

Will intricate masking be needed?

Knowing the size and geometry of the component helps determine the feasibility of powder coating as well as determining which application method is the most efficient. The most common application methods are:

Fluid Bed Dip – Components are preheated and dipped into a powder fluid bed or powder hopper. The epoxy begins to gel immediately upon contact with the hot substrate.

Venturi Spray – Components are preheated and powder is applied using venturi nozzles or powder spray guns. The epoxy begins to gel immediately upon contact with the hot substrate.

Electrostatic Spray – Powder is sprayed using an electrostatic application gun. This is a common method used by powder coaters globally. Powder is positively charged either by a high-voltage corona or triboelectric friction. The charged particles adhere to grounded components. Parts can be coated at room temperature; however, thicker film builds are obtained when applying powder to preheated components.

Electrostatic Fluid Bed – This is similar in construction to a standard powder fluid bed; however, the air feeding the powder chamber is electrostatically charged, creating a cloud of powder. The charged particles from the cloud adhere to grounded components. Parts are typically at room-temperature when coated using this method.

Step 3:
Select the 3M™ Powder Resin that best fits the needs

What temperature will the coating be subject to?

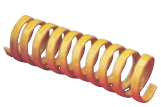
Is UL Recognition of importance? What dielectric strength is needed?

What heating methods are available to cure the powder coating?

These are only a few of the questions that should be addressed prior to selecting a coating. The chart which begins on page 16 will list a number of performance criteria that can help narrow down the product selection.

- The substrate to which the powder epoxy is being applied plays an important role in the adhesion performance of the coating.
- The 3M Scotchcast Powder Resins adhere well to carbon steel, aluminum and copper.
- Surface preparation, oxidation, existing insulation coatings and substrate alloy need to be taken into consideration.
- To obtain the best adhesion, substrate cleanliness is absolutely necessary.
- Alloy selection may have an impact on coating adhesion as well.

Typical Property Data

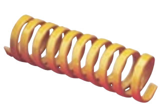
3M™ Powder Resin Product Number	Temp. Class[1]	Description	UL System 1446 Approved File Number E163090	UL 746B Comp.	Cure Schedules (Temp/Time)
 **260** **260CG**	H	This widely used, well-known product is used primarily in spray and fluid bed dip applications. 3M™ Scotchcast™ Resin 260CG is a course-ground version of Resin 260 for improved fluidized bed performance. UL Recognized. Data Sheet-260 Safety Data Sheet-260 Data Sheet-260CG Safety Data Sheet-260CG	✓	E35075	149°C (300°F) 30 min. 177°C (350°F) 10 min. 204°C (400°F) 45 sec. 232°C (450°F) 20 sec.
 **262**	B	This resin has excellent flow characteristics that produce a uniform coating in applications, such as resistance heated bobbin-wound coils. It is used primarily in spray and fluid bed dip applications. Data Sheet Safety Data Sheet			149°C (300°F) 40 min. 177°C (350°F) 20 min. 204°C (400°F) 60 sec. 232°C (450°F) 30 sec.
 **263**	H	Resin 263 is used primarily in spray and fluid bed dip applications and has been designed for use where high-temperature cut-through resistance is required. UL Recognized. Data Sheet Safety Data Sheet	✓	E35075	149°C (300°F) 30 min. 177°C (350°F) 10 min. 204°C (400°F) 30 sec. 232°C (450°F) 20 sec.
 **265**	H	Low melt viscosity and minimum build make this unfilled powder ideal for a variety of coating, bonding and impregnating applications, notably coating from a solvent. Data Sheet Safety Data Sheet	UL 1446 thermal classification of 200°C (392°F) helical coil and 180°C (356°F) twisted pair with MW 35 magnet wire. File number E309208	E309208	149°C (300°F) 60 min. 177°C (350°F) 20 min. 204°C (400°F) 5 min. 232°C (450°F) 2 min.
 **5230N**	H	Resin 5230N was designed with excellent electrostatic charging capabilities It provides smooth, uniform film build with good slot penetration when applied using an electrostatic fluid bed. UL Recognized method. Data Sheet Safety Data Sheet	✓	E35075	177°C (350°F) 15 min. 204°C (400°F) 6 min. 232°C (450°F) 3 min.
 **5400**	F	Resin 5400 was developed for continuous coating of wire products by electrostatic fluidized bed. Excellent flexibility and resistance to cracking due to heat shock or impact are just several of the very excellent characteristics. Data Sheet Safety Data Sheet			177°C (350°F) 5 min. 204°C (400°F) 150 sec. 232°C (450°F) 50 sec.
 **5555 10G** **5555 22G**	H	Resin 5555 can be applied via cold electrostatic spray or electrostatic fluid bed. It also can be applied to pre-heated components by fluid bed dipping or by spraying. Its versatility allows this powder to be used on a wide variety of motor stators, armatures and other metal components needing electrical insulation. UL Recognized. Data Sheet-5555 10G Safety Data Sheet-5555 10G Data Sheet-5555 22G Safety Data Sheet-5555 22G	✓	E35075	**5555 10G:** 177°C (350°F) 6 min. 204°C (400°F) 150 sec. 232°C (450°F) 90 sec. **5555 22G:** 177°C (350°F) 8 min. 204°C (400°F) 4 min. 232°C (450°F) 2 min.

Test methods

[1] AIEE standard.

Typical property data for powder resins continues on next page >>>

Typical Property Data (continued from previous page)

	3M™ Powder Resin Product Number	Specific Gravity	Cut-Through Resistance	Edge Coverage (%)	Impact Resistance (inch-lbs. Newton Meters)	Gel Time @ 193°C Hot Plate	Dielectric Strength (volts/mil)	Volume Resistivity (Ohm-Cm at 23°C)	Color
	260 260CG	1.43	215°C (410°F)	>35	100 inch-lbs (11.3 J)	12-16 sec. @ 380°F (193°C)	1,000 V/mil (39V/micron) 12-15 mil (305 μm to 381 μm) film thickness)	10^{15}	Green
	262	1.34	130°C (266°F)	>38	100 inch-lbs (11.3 J)	12-16 sec. @ 380°F (193°C)	1,000 V/mil (39 V/micron) 12-15- mil (305 μm to 381 μm) film thickness)	10^{13}	Red
	263	1.47	290°C (554°F)	>40	100 inch-lbs (11.3 J)	8-14 sec. @ 380°F (193 C)	1,000 V/mil (39 V/micron) 12-15 mil (305 μm to 381 μm) film thickness)	10^{15}	Green
	265	1.16	N/A	N/A	160 inch-lbs (18.1J)	60 sec. @ 380°F (193°C)	1,300 V/mil (51 V/micron) 12-15 mil (305 μm to 183 μm) film thickness	10^{14}	Clear
	5230N	1.60	320°C (608°F)	>35	160 inch-lbs (18.1J)	9-16 sec. @ 380°F (193°C)	1000 V/mil (39 V/micron) 12-15 mil (305 μm to 381 μm) film thickness	10^{15}	Blue
	5400	1.22	292°C (557°F)	N/A	N/A	15-25 sec. @ 400°F (204°C)	1200 V/mil (47 V/micron) 5 mil (127 μm) film thickness	10^{14}	Yellow Tan
	5555 10G 5555 22G	1.7	340°C (644°F)	**5555 10G:** > 35% **5555 22G:** > 30%	100 inch-lbs (11.3 J)	**5555 10G:** 9-11 sec. @ 392°F (200°C) **5555 22G:** 21-23 sec. @ 392°F (200°C)	1300 V/mil (512 V/micron) 12-15 mil (305 μm to 381 μm) film thickness	10^{14}	Green

Other Insulating Solutions from 3M

3M offers a variety of insulating and protecting products that are performance engineered to meet rigorous applications at a range of temperatures.

Other Insulating Solutions from 3M (continued from previous page)

Flexible Insulation

3M Flexible Insulation includes state-of-the-art insulating papers and laminates that 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 appliance. These primarily inorganic materials typically retain a high percentage of dielectric strength, even after extended exposure to high operating temperatures.

Insulating Tapes

3M Insulating and Conductive Tapes are made from a broad range of backings and adhesives to meet the demanding requirements of different applications and environments. Extensive quality control and testing, combined with accurate process controls, are just part of the reason that 3M consistently provides high-quality insulating products.

Heat Shrink Tubing and Molded Shapes

3M Heat Shrink Products provide an effective means of applying skin-tight insulating and protective coverings for a wide variety of electrical, electronic and mechanical applications. These products from 3M offer the important advantages of simple installation, excellent performance and long-term reliability. 3M also makes cold-shrink tubing designed for insulation wire and cable and for strain relief and physical protection.

Important Notice

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