3M™ Scotchcast™ OEM Resins
Product Selection Guide

Reliable Coatings and Insulation

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 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 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.

Selection process

The Scotchcast 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 seven. 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.

Room cure or oven cure

In answering this question, consider:

The availability of ovens.

If unavailable, or if their purchase cannot be justified by application, volume, or rate requirements, a room-temperature curing resin must be selected.

The application process (i.e., dipping, potting, casting, impregnation, bonding).

From a production and engineering standpoint, oven cures are more versatile than room cures because they have long pot lives, short cure times and their viscosities can be lowered by warming.

The number of units to be processed.

Oven-curing resins are usually used in high-volume applications because they are less expensive than their room-curing counterparts. The expense of ovens is offset by a decrease in resin cost.

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 could act as a heat insulator and cause the interior temperature to rise rapidly. If uncontrolled, this rise in temperature could exceed the maximum temperature 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-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.

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3M™ Scotchcast™ Liquid Resin Selection

Step 1: Select Type of Resin Cure Needed		Step 2: Select Degree of Flexibility Needed	Step 3: Select Temperature Class Required	Step 4: Select Resin Selection Desired
Oven Cure Resins	**Oven Cure Unfilled Resins** Lower Viscosity Better Impregnation	Rigid	Class F	250
		Rigid	Class B	3
		Semiflexible	Class F	280
		Semiflexible	Class B	235
	Oven Cure Filled Resins Medium Viscosity Higher Thermal Conductivity Better Dimensional Stability	Rigid	Class F	251
		Semiflexible	Class F	281, MR283 F075
		Semiflexible	Class B	241, 255
	Oven Cure Thixotropic Resins Highly Filled Dipping, Buttering Applications	Rigid	Class F	252
		Semiflexible	Class F	282
		Semiflexible	Class B	253
Room Cure Resins	**Room Cure Unfilled Resins** Lower Viscosity Better Impregnation	Rigid	Class B	5
		Semiflexible	Class B	8, 208
		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	9
		Flexible	Class 0	2131
	Room Cure Thixotropic Resins Highly Filled Troweling, Buttering Applications	Semiflexible	Class B	10, 210

Room Cures
Typical Property Data

Polymer Cure/ Cured Form/ Filler/Color	Temperature Class	Product Number	Description	Mixing Ratio A/B	Viscosity[1] @ 25°C (77°F) (Centipoise)	Cure Schedules[2] (Temp/Time)	Gel Time[3] (Minutes)
Polyurethane Room Temp 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 minimizes potential toxicity.	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 Temp Rigid Unfilled Clear Amber	B	5	Resin 5 is a general purpose, very low viscosity, chemical and moisture-resistant, transparent epoxy with a long pot life and low exotherm when compared to similar products.	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 Temp Semiflexible Unfilled Clear Amber Reddish Brown	B	8 208	Resin 8 is a clear, general purpose electrical 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.	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 Temp Semiflexible Filled Reddish Brown	B	9	This medium viscosity, filled version of Resin 8 possesses all the good features of 8 plus very low exotherm, less shrinkage (even lower stress), improved thermal shock resistance and higher thermal conductivity. Self extinguishing. Tested to MIL-I-16923G	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 Temp Semiflexible Filled (paste) Reddish Brown	B	10 210	Both of these products have a heavy paste (peanut butter) consistency. Resin 10 is for general use. Resin 210 is supplied in kit for use primarily as a motor repair resin. They are versions of 9 and exhibit many of its good features. Self extinguishing.	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)
Polybutadiene Room Temp Soft, reenterable Unfilled Translucent amber	0	2123	3M™ Scotchcast™ Re-enterable Electrical 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.	Wt 1:1 Vol (%) 48:52	A= 350-750* B= 700-1400*	21°C (70°F) 24 hrs.	62 min
Polyurethane Room Temp 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.	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

Test methods

1. Brookfield Viscometer
2. 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.
3. 3M Test Method, using Sunshine Gel Timer
4. Shore A = Immediate per ASTM D 2240
   Shore D = Immediate per ASTM D2240
   Barcol = Immediate per Barcol Hardness Tester
5. ASTM D792
6. Olyphant Inserts = 3M Test Method (1/8 inch = 3,175 mm, 1/4 inch = 6,35 mm)
7. ASTM D696
8. ASTM D638
9. ASTM D570, 240 hrs. @ 96% R.H.
10. ASTM D149
11. ASTM D257
12. ASTM D570-81, 24 hr. immersion @ 23°C

Hardness[4]	Specific Gravity[5]/ Density (Cured)	Thermal Shock Resistance[6] (Passes 10 Cycles At Specified Temperature Range And Insert Size)	Linear Thermal Expansion[7] (Length/Unit Length/°C)	Tensile Strength[8] (psi)	Thermal Conductivity[7] W/Mk	Moisture Absorption[9, 12] (% Wt Gain)	Dielectric Strength[10] (Volts Per Mil. 1/8 Inch Sample)	Volume Resistivity[11] (Ohm-Cm At 23°C)
75 Shore A	1.06/ 8.85 lb/gal	130°C to -55°C 1/4 inch insert	23×10^{-5}	980	0.20	120 days 71°C, 95% R.H. = 0.45%	420	10^{13}
15 Barcol	1.12/ 9.35 lb/gal	Fails 1/8 inch insert	17.7×10^{-5}	8000	0.18	0.50[9]	325	10^{14}
68 Shore D	1.12/ 9.35 lb/gal	130°C to -55°C 1/8 insert	15×10^{-5}	1700	0.18	1.60[9]	325	10^{13}
70 Shore D	1.42/ 11.85 lb/gal	130°C to -55°C 1/4 inch insert	13×10^{-5}	2200	0.30	0.80[9]	350	10^{13}
70 Shore D	1.55/ 12.94 lb/gal	130°C to -55°C 1/4 inch insert	8.6×10^{-5}	1500	0.34	0.44[9]	350	10^{12}
0 Shore A	0.53 oz./in.(3) [cubed]	*	*	10.7	10.7	0.2	>240	
82 Shore A	0.69 oz./in.(3) [cubed]	*	*	1038	1038	4.9	343	

* - Call Technical Service for details

Oven Cures
Typical Property Data – Unfilled Resins

Polymer Cure/ Cured Form/ Filler/Color	Temperature Class	Product Number	Description	Mixing Ratio A/B	Viscosity[1] @25°C (77°F) (Centipoise)	Cure Schedules[2] (Temp/Time)	Gel Time[3] (Minutes)
Epoxy Oven Temp 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.	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
Epoxy Oven Temp 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.	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
Epoxy Oven Temp Semiflexible Unfilled Clear Amber	F	280	This product is characterized by its high-temperature stability, superior electrical properties and thermal shock resistance.	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) 3-4 hrs.	20
Epoxy Oven Temp Semiflexible Unfilled Reddish-Brown	B	235	Permanent semiflexibility, thermal shock and impact resistance, stable properties, good electricals and adhesion are features of Resin 235. Very low viscosity and good wetting ability allow for complete impregnation of small voids.	Wt 1:2 Vol (%) 31:69	A = 13,000 B = 1,000 Mixed = 1,800	75°C (167°F) 15-20 hrs. 95°C (203°F) 6-8 hrs. 120°C (248°F) 2-3 hrs.	18

Filled Resins

Polymer Cure/ Cured Form/ Filler/Color	Temperature Class	Product Number	Description	Mixing Ratio A/B	Viscosity[1] @25°C (77°F) (Centipoise)	Cure Schedules[2] (Temp/Time)	Gel Time[3] (Minutes)
Epoxy Oven Temp Rigid Filled Brown	F	251	This medium viscosity, filled version of 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.	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
Semiflexible Filled Cream	F	F0275	This product is formulated for excellent thermal shock resistance and hydrolytic stability, low embedment stress, and strong electrical properties.	Wt 5:1 Vol (%) 36.3:10	A = 40,000 B = 150 Mixed = 6,800	75° C (167° F) 36-48 hrs. 95° C (203° F) 8-10 hrs. 120° C (248° F) 3-4 hrs.	30
Epoxy Oven Temp Semiflexible Filled Off-White	B	255	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.	Wt 2:3 Vol (%) 39:61	A = 12,000 B = 40,000 Mixed = 25,000	82°C (180°F) 16-20 hrs. 121°C (250°F) 3-4 hrs.	21
Epoxy Oven Temp Semiflexible Filled Cream	F	281	This filled version of Resin 280 offers many of the key features of resin 280 plus lower shrinkage, improved thermal and mechanical shock resistance, plus high thermal conductivity.	Wt 2:3 Vol (%) 37:63	A = 320,000 B = 38,000 Mixed = 75,000	75°C (167°F) 24 hrs. 95°C (203°F) 6-8 hrs. 120°C (248°F) 3-4 hrs.	21
Epoxy Oven Temp Semiflexible Filled Reddish-Brown	B	241	This filled version of Resin 235 offers many of the key features of resin 235 plus lower shrinkage, improved thermal and mechanical shock resistance, and increased thermal conductivity. Self extinguishing.	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

Hardness[4]	**Specific Gravity**[5]**/ Density** (Cured)	**Thermal Shock Resistance**[6] (Passes 10 Cycles At Specified Temperature Range And Insert Size)	**Linear Thermal Expansion**[7] (Length/Unit Length/°C)	**Tensile Strength**[8] (psi)	**Thermal Conductivity**[7] W/Mk	**Moisture Absorption**[9, 12] (% Wt Gain)	**Dielectric Strength**[10] (Volts Per Mil. 1/8 Inch Sample)	**Volume Resistivity**[11] (Ohm-Cm At 23°C)
25 Barcol	1.06/ 8.85 lb/gal	Fails 1/8 inch insert	6.5×10^{-5}	7780	0.15	0.30[9]	325	10^{16}
80 Shore D	1.12/ 9.35 lb/gal	Fails 1/8 inch insert	20×10^{-5}	4400	0.17	0.50[9]	300	10^{15}
73 Shore D	1.12/ 9.35 lb/gal	130°C to -65°C 1/8 insert	21×10^{-5}	1950	0.22	0.52[9]	375	10^{15}
55 Shore D	1.42/ 11.85 lb/gal	130°C to -55°C 1/8 inch insert	16×10^{-5}	1300	0.17	0.92[9]	325	10^{15}

Hardness[4]	**Specific Gravity**[5]**/ Density** (Cured)	**Thermal Shock Resistance**[6] (Passes 10 Cycles At Specified Temperature Range And Insert Size)	**Linear Thermal Expansion**[7] (Length/Unit Length/°C)	**Tensile Strength**[8] (psi)	**Thermal Conductivity**[7] W/Mk	**Moisture Absorption**[9, 12] (% Wt Gain)	**Dielectric Strength**[10] (Volts Per Mil. 1/8 Inch Sample)	**Volume Resistivity**[11] (Ohm-Cm At 23°C)
40 Barcol	1.50/ 12.52 lb/gal	Fails 1/8 inch insert Passes MIL-I-16923G (105°C to -55°C)	5×10^{-5}	5280	0.33	0.25[9]	425	10^{15}
80 Shore C	1.55	155°C to -65°C 1/8 inch insert	17×10^{-5}	3700	0.46	0.15[12]	372	10^{15}
72 Shore D	1.56/ 13.02 lb/gal	130°C to -55°C 1/4 inch insert	15×10^{-5}	1500	0.19	0.45[9]	375	10^{15}
73 Shore D	1.43/ 11.93 lb/gal	130°C to -65°C 1/4 inch insert	15×10^{-5}	2100	0.50	0.32[9]	375	10^{15}
65 Shore D	1.42/ 11.85 lb/gal	130°C to -55°C 1/4 insert	13.6×10^{-5}	1300	0.33	0.60[9]	375	10^{15}

Filled Resins (cont'd)

Polymer Cure/ Cured Form/ Filler/Color	Temperature Class	Product Number	Description	Mixing Ratio A/B	Viscosity[1] @25°C (77°F) (Centipoise)	Cure Schedules[2] (Temp/Time)	Gel Time[3] (Minutes)
Epoxy Oven Temp Rigid Filled Thixotropic Reddish-Brown	F	252	Resin 252 is a thixotropic version of 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.	Wt 1:1 Vol (%) 50:50	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.	21
Epoxy Oven Temp Semiflexible Filled Thixotropic Cream	B	282	Resin 282 is a thixotropic version of 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.	Wt 2:3 Vol (%) 37:63	A=Thixotropic B=Thixotropic Mixed= Thixotropic	82°C (180°F) 16-20 hrs. 121°C (250°F) 3-4 hrs.	23
Epoxy Oven Temp Semiflexible Filled Thixotropic Reddish-Brown	F	253	This product offers many of the advantages of 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.	Wt 1:2 Vol (%) 30:70	A=Thixotropic B=Thixotropic Mixed= Thixotropic	75°C (167°F) 24 hrs. 95°C (203°F) 6-8 hrs. 120°C (248°F) 3-4 hrs.	25 min. @ 120°C (248°F)
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.				

Scotchcast liquid resins are easy-to-use two-part systems

Hardness[4]	**Specific Gravity**[5]**/ Density** (Cured)	**Thermal Shock Resistance**[6] (Passes 10 Cycles At Specified Temperature Range And Insert Size)	**Linear Thermal Expansion**[7] (Length/Unit Length/°C)	**Tensile Strength**[8] (psi)	**Thermal Conductivity**[7] W/Mk	**Moisture Absorption**[9, 12] (% Wt Gain)	**Dielectric Strength**[10] (Volts Per Mil. 1/8 Inch Sample)	**Volume Resistivity**[11] (Ohm-Cm At 23°C)
45 Barcol	1.51/ 12.60 lb/gal	Fails 1/8 inch insert Passes MIL-I-16923G (105°C to -55°C)	4×10^{-5}	6000	0.29	0.35[9]	325	10^{14}
73 Shore D	1.43/ 11.93 lb/gal	130°C to -65°C 1/4 inch insert	15×10^{-5}	2100	0.50	0.32[9]	375	10^{15}
65 Shore D	1.50/ 12.52 lb/gal	130°C to -55°C 1/4 inch insert	12.6×10^{-5}	1300	0.33	0.69[9]	375	10^{15}

Continued from page 4

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) 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)

Application Considerations

In addition to these four basic questions, 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 are pigmentable. 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 6 shows the wide viscosity range of 3M™ Scotchcast™ Electrical Liquid Resins. The values listed for Scotchcast resins 3, 235 and 241 at various temperatures show how viscosity can be lowered by heating. Values are at room temperature or 25°C (77°F), unless otherwise indicated.

3M™ Scotchcast™ Powder Resins

Selection and Application

Powder resin selection depends primarily on the method of application available. The five 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. Besides evaluating the property values, product descriptions and selection chart on the next few pages, consider the following:

Application

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

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 blasting, vapor de-greasing, or steam cleaning.

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.

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 its melt rate and melt viscosity.

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.

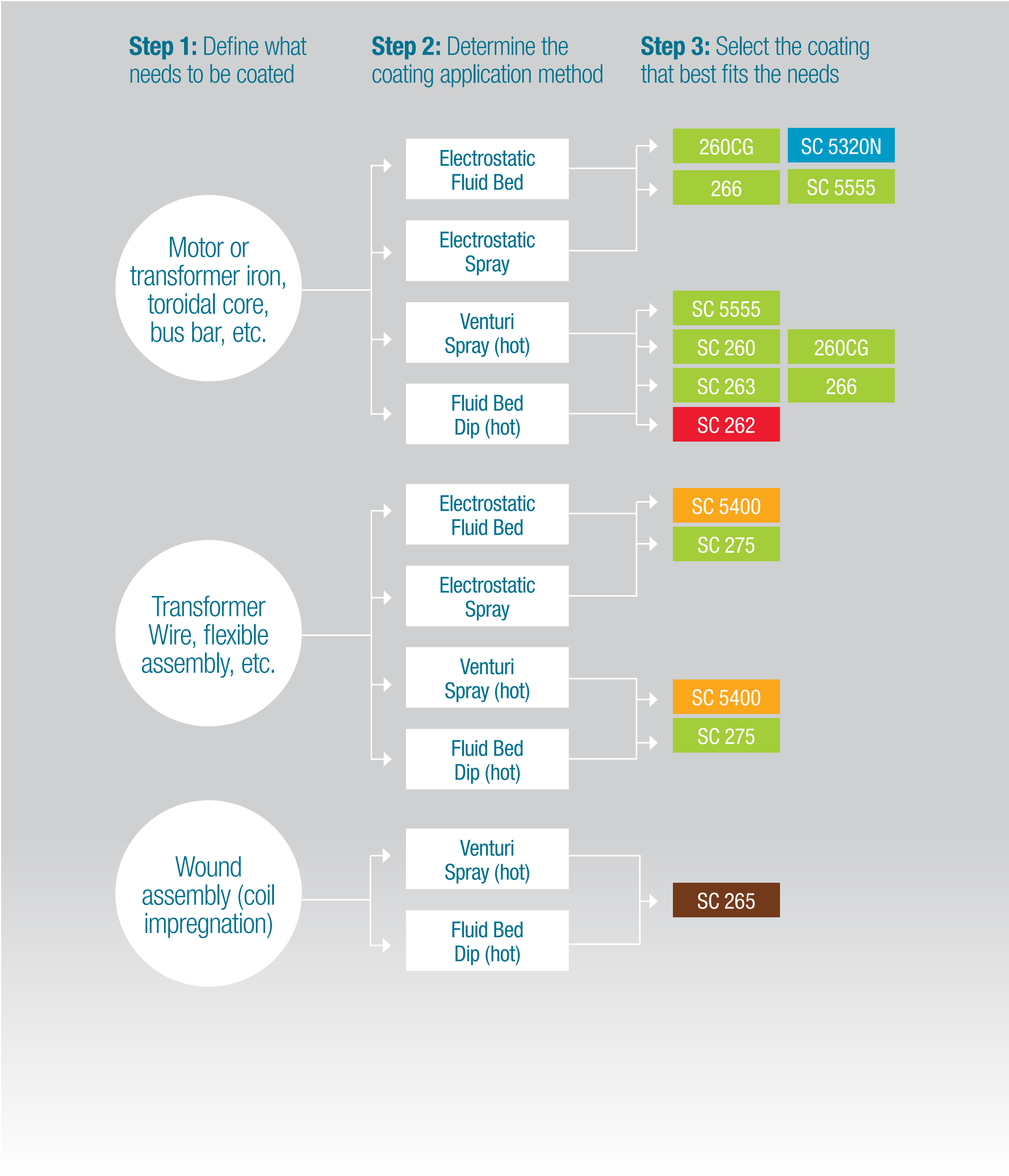
4. Cure the resin

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 14 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 UL file E35075 (QMFZ2) and E309208 (OBOR2).

What component needs to be insulated?



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 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.

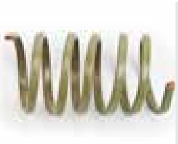
Step 3: Select the coating that best fits the needs

- 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 questions that should be addressed prior to selecting a coating. The chart on pages 14-15 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™ Power 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.

Powder Resins Typical Property Data

Temp Class	Product Number		Description	UL System 1446 Approved File Number E163090	UL 746B Component	Cure Schedules (Temp/Time)
H	260 260CG		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.	✓	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 450°F (323°C) 5 min
B	262		This resin has excellent flow characteristics which produce a uniform coating in applications such as resistance heated bobbin-wound coils. It is used primarily in spray and fluid bed dip applications.			149°C (300°F) 40 min 177°C (350°F) 20 min 204°C (400°F) 60 sec 232°C (450°F) 30 sec
H	263		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.	✓	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
H	265		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.		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
B	266		Resin is specially formulated for application using the electrostatic fluid bed or spray process, but can be used with conventional fluid beds also. It is similar in color to Scotchcast 260 resin and features improved impact resistance. Also available in a blue/green version designated Resin 266 TC.		E35075	177°C (350°F) 5 min 204°C (400°F) 150 sec 232°C (450°F) 50 sec
	275		Excellent flexibility while maintaining good dielectric strength is the key characteristic of Resin 275. This ability to bend makes this coating ideal for coating wire products or other flexible assemblies.		No	350°F (177°C) 20 min 375°F (191°C) 12 min 400°F (204°C) 8 min 425°F (218°C) 6 min 450°F (232°C) 5 min
F	5230N		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.	✓	E35075	177°C (350°F) 15 min. 204°C (400°F) 6 min. 232°C (450°F) 3 min.
H	5400		Resin 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			200°C (392°F) 15 min 250°C (482°F) 5 min 300°C (572°F) 90 sec 350°C (662°F) 30 sec
H	5555 10G 5555 22G		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.	✓	E35075	204°C (400°F) 10G 150 sec 22G 4 min.

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
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
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
1.47	290°C (554°F)	>40	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^{15}	Green
1.16	N/A	N/A	160 inch-lbs (18.1J)	7-15 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
1.55	260°C (500°F)	.35	160 inch-lbs (18.1J)	60 sec @ 380°F (193°C)	1,000V/mil (39 V/micron) 12-15 mil (305 µm to 381 µm) fim thickness	10^{14}	Green
1.21	N/A	N/A	160 inch-lbs (18.1J)	15 - 20 Sec @ 400°F (204°C)	1,000V/mil (39 V/micron) 12-15 mil (305 µm to 381 µm) fim thickness	N/A	Green
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
1.22	170°C (338°F)	N/A	160 inch-lbs (18.1J)	15-25 sec @ 400°F (204°C)	1200 V/mil (47 V/micron) 5 mil (127 µm) film thickness	10^{14}	Yellow Tan
1.7	340°C (644°F)	>35 (10G) >40 (22G)	100 inch-lbs (11.3 J)	9-11 sec @ 392°F (200°C) (10G) 21-23 sec @ 392°F (200°C) (22G)	1300 V/mil (512 V/micron) 12-15 mil (305 µm to 381 µm) film thickness	10^{14}	Green

Other Insulating Solutions from 3M Company

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

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 a uniquely 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.

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