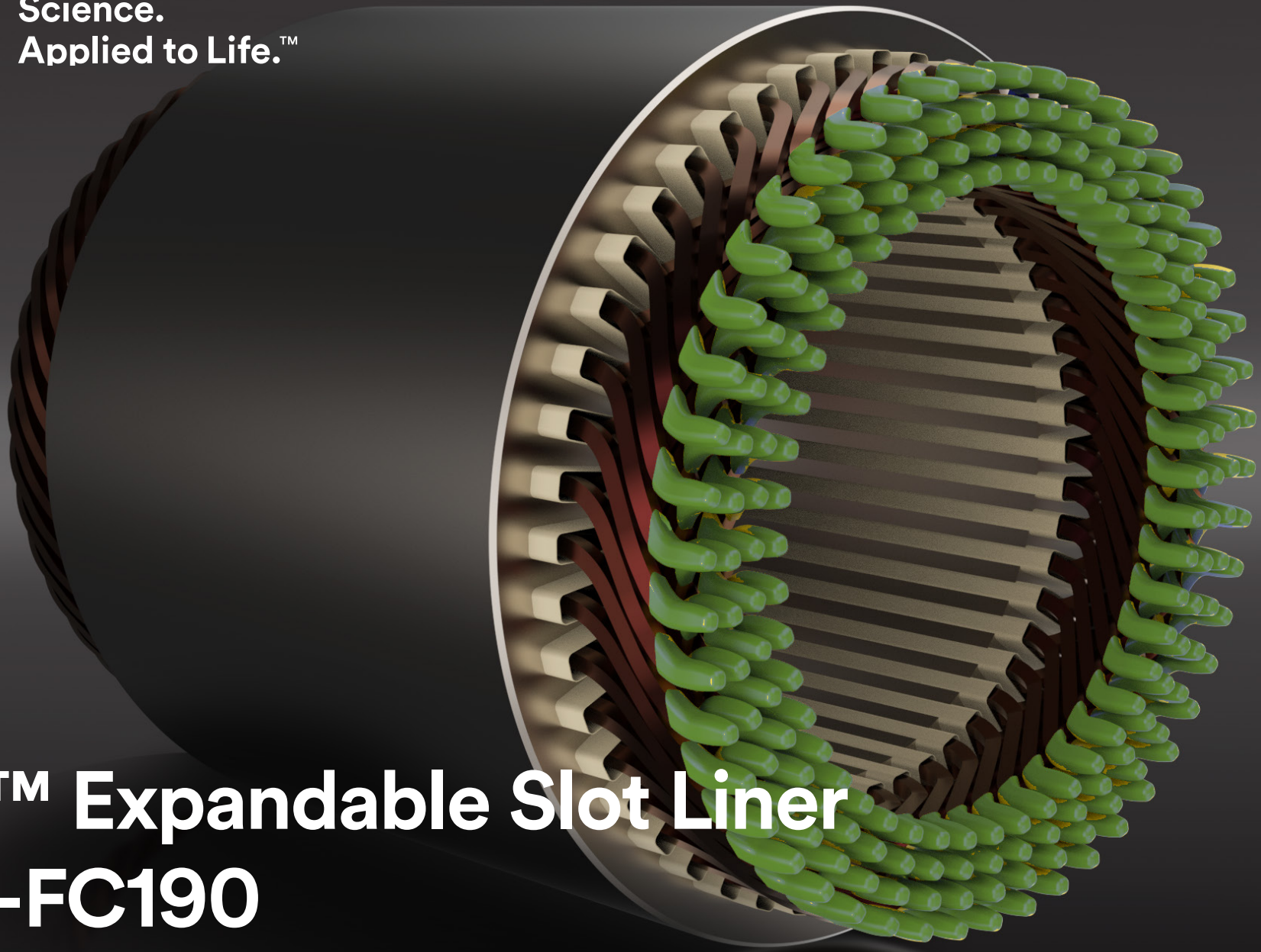
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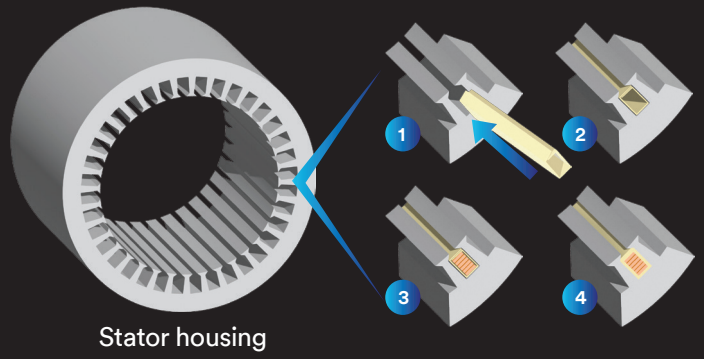


3M™ Expandable Slot Liner ESL-FC190

Intended Use: These products are intended for use within electric motors to electrically insulate coil conductor from adjacent conductor or ground in automotive, off-highway, industrial and marine applications. Since there are many factors that can affect a product's use, the customer remains responsible for determining whether the 3M product is suitable and appropriate for the customer's specific application and system, including customer conducting an appropriate risk assessment and evaluating the 3M product in customer's application and system.

Restricted Use: 3M advises against the use of this 3M product in any application other than the stated intended use(s), since other applications have not been evaluated by 3M and may result in an unsafe or unintended condition.

3M™ Expandable Slot Liner ESL-FC190



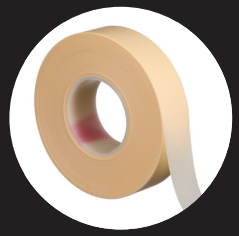
3M™ ESL Insulation is inserted into stator slots

Heat is used to expand and cure the 3M™ ESL adhesive layer

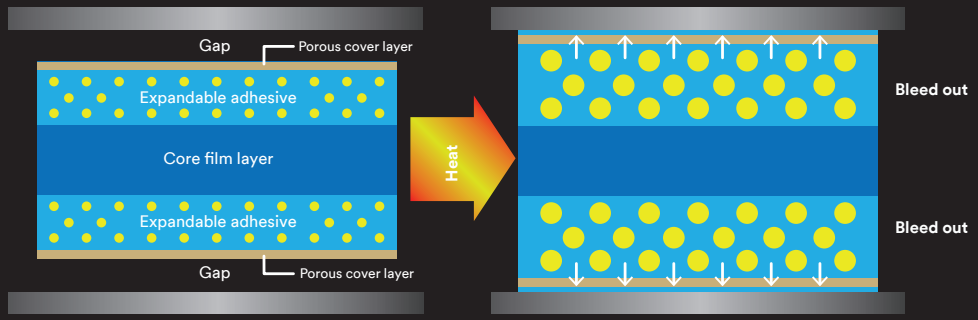
3M™ Expandable Slot Liner ESL-FC190

- For motors that use rectangular-shaped wires
- Eliminates the need for the varnish process, helping you to improve your manufacturing efficiency
- Smooth surface ideal for automatic insertion equipment
- Electrically isolates, mechanically protects, and securely holds the coils

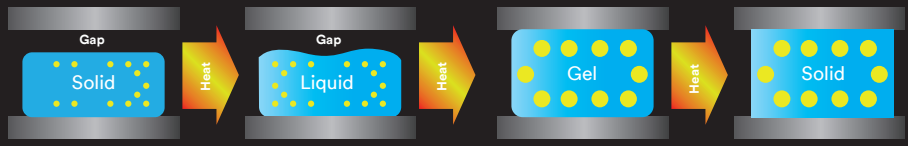
Cross section view







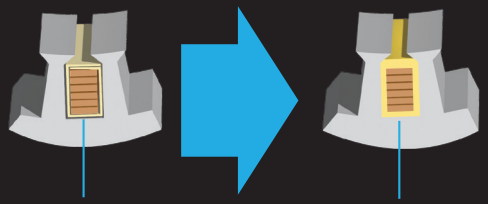
Heat expands and cures the adhesive layer



Material Performance

Test condition	Items	Typical value	Sample condition
Initial	Total thickness	0.19mm	Uncured
	Tensile strength	300 N/15mm	Uncured
	Elongation	65%	Uncured
	Dielectric Breakdown Voltage (in oil)	14 kV	Uncured
	Overlap shear strength in RT	6.2 MPa	Cured with 0.3mm total gap
	Overlap shear strength in 200°C	1.6 MPa	
ATF resistance ATF 150degC 1000h	Dielectric Breakdown Voltage (in oil)	14 kV	Cured
	Overlap shear strength in RT	5.1 MPa	Cured with 0.3mm total gap
	Overlap shear strength in 200°C	1.8 MPa	
Heat resistance 200degC 500h	Dielectric Breakdown Voltage (in oil)	12kV	Cured
	Overlap shear strength in RT	2.3 MPa	Cured with 0.3mm total gap
	Overlap shear strength in 200°C	1.4 MPa	
High-temp. & humidity resistance 85degC 85%RH 1000h	Dielectric Breakdown Voltage (in oil)	12 kV	Cured
	Overlap shear strength in RT	4.6 MPa	Cured with 0.3mm total gap
	Overlap shear strength in 200°C	0.7 MPa	
Heat shock cycle -40degC(30min.) 180degC(30min.) 300cycles	Dielectric Breakdown Voltage	12 kV	Cured
	Overlap shear strength in RT	4.2 MPa	Cured with 0.3mm total gap
	Overlap shear strength in 200°C	1.8 MPa	
Apparent Thermal Conductivity	Apparent Thermal Conductivity (ASTM D5470)	0.08W/m.K	Cured with 0.3mm total gap

3M™ Expandable Slot Liner ESL-FC190: Eliminating Varnish



Slot liner expanded by heat to fill the gap and to adhere with stator core and coils

Conventional process	Proposed process
Conventional slot liner inserted into slots	Expandable Slot Liner inserted into slots
Coil winding inserted into the insulated slots	Coil winding inserted into the insulated slots
Varnishing	-
Heating for varnish curing	• Heating for expansion (room temp to 160°C, 3 minutes) • Heating for cure (160°C, 10 minutes) - Curing time may be adjusted depending on temperature

Varnish and varnish rework process can be eliminated

eMotor Trends and Needs

1 eMotor Trend 1 - Cooling System (from indirect to direct cooling)

A. Water-jacket indirect cooling



- Simple design
- Utilized in early EV motor designs

B. ATF (Automatic Transmission Fluid) direct cooling



- Direct cooling of stator end turns
- Requires chemical compatibility of insulation materials

2 eMotor Trend 2 – Hairpin (rectangular wire)

Stator Wire Type		Advantages	Disadvantages
(A) Small Round Wire (random wound)		• Lower cost • Mechanized construction	Lower slot fill factor Poor heat dissipation capability
(B) Rectangular Wire (hairpin wound)		• Uniform temp distribution and turn-to-turn voltage stress • Ideal for high power applications • Higher slot fill factor	More costly and difficult to manufacture Produce more copper losses at high frequency

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