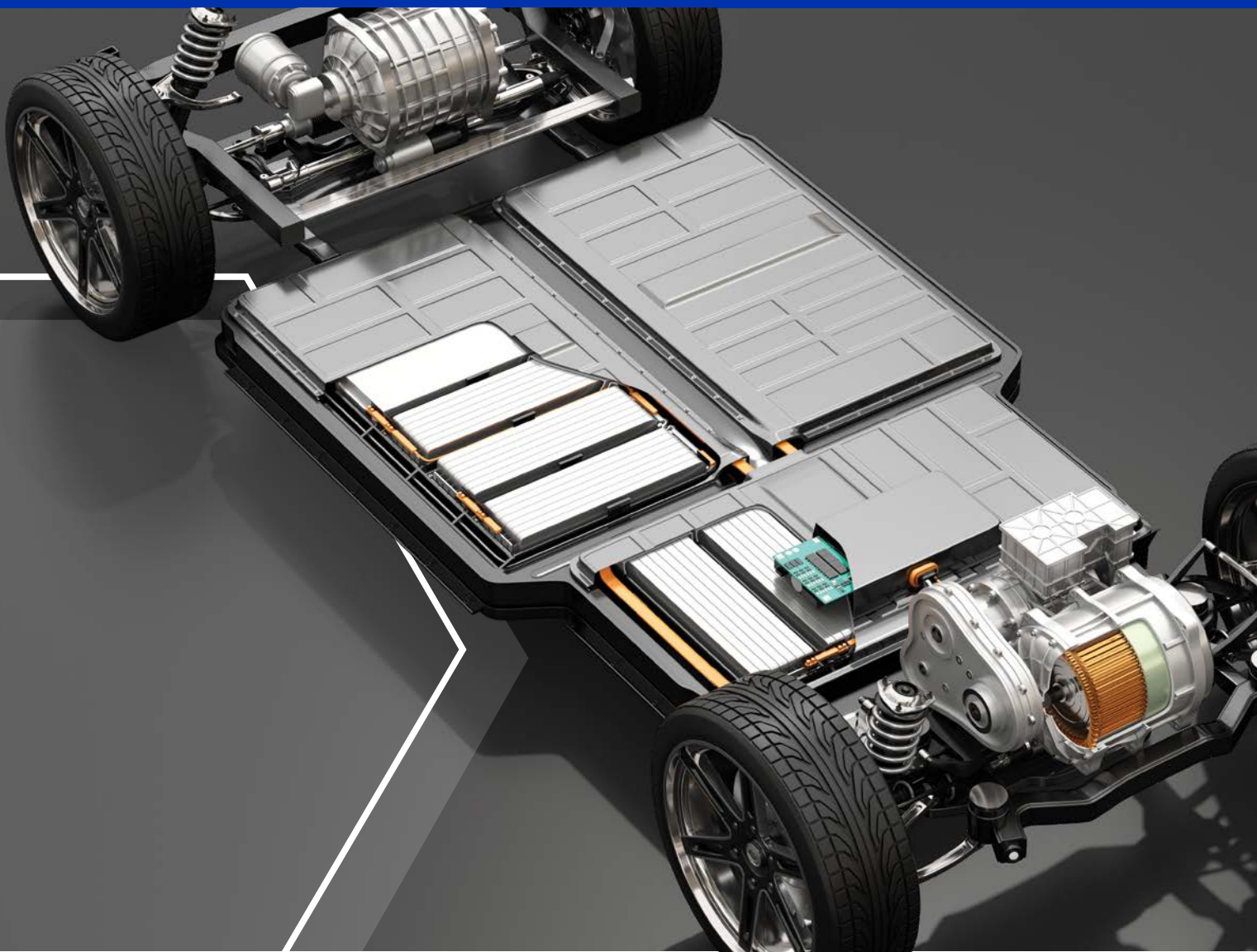


SOLUTIONS FOR EV BATTERY MANUFACTURING

Bonding | Sealing | Coating | Thermal Management | Material Transfer



M O V I N G M A T E R I A L S T H A T M A T T E R [™]



A STRONG BOND WITH eMOBILITY

The world of transportation is changing rapidly. Electrification represents the largest change in transportation since the invention of the internal combustion engine.

At the heart of electrification is the lithium-ion battery. Ongoing advancements in energy density, safety and cost-to-produce are driving mass electrification of transportation. From raw material transfer, battery cell manufacturing, and battery pack assembly, to even the lubrication solutions for production line equipment, all steps are carefully designed to ensure smooth manufacturing processes.

As you scale from prototype to mass manufacturing, you need a partner you can count on. Graco is a worldwide leader of fluid handling in automotive and battery dispensing equipment. Our experts have vast experience in some of the most challenging applications. Our commitment is to meet today's challenges and develop new solutions that will keep our customers at the forefront.

GRACO OFFERS eMOBILITY SOLUTIONS FOR:

- Battery Cell Manufacturing
- Battery Module and Pack Assembly
- Machine Lubrication

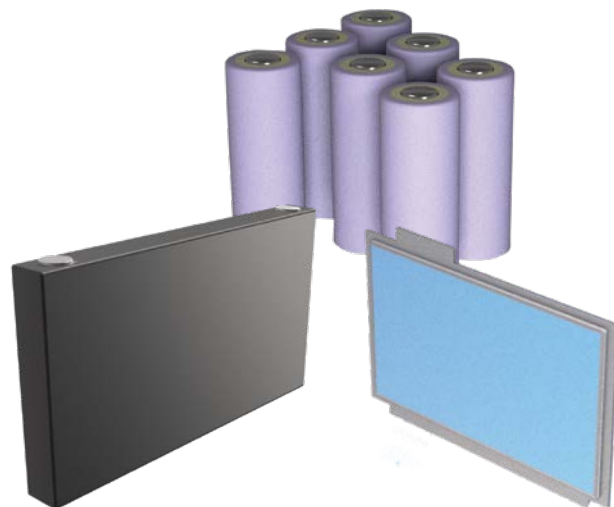
BATTERY CELL MANUFACTURING

Material Transfer

In the production process of NCM precursors of cathode materials or LFP, the diaphragm pump is used for the transfer, transportation, filtration and washing of the slurry after the precipitation reaction, the circulation of the slurry during the concentration of the synthesis kettle, and the conveying of water-based or alcohol-based high-solids slurries, the high abrasive material feeding in grinding process and the intermittent replenishment of slurry metering tanks in membrane coating, etc.

GRACO SOLUTIONS

Double Diaphragm Pumps: QUANTM Electric (EODD), Husky Air Operated (AODD)



MACHINE LUBRICATION

Automatic Lubrication

Lubrication points that require drag chain and leak monitoring, such as multi-axis modules in the battery cell section. Specialized equipment with densely packed lubrication points, such as wrapping machines (including battery loading modules, core assembly modules, re-flow translation modules, MLD/pre-welding inspection modules, etc.), totaling 290 lubrication points – sliders, modules, motors, and bearings. Equipment requiring large volumes of lubrication. Delivering grease at the proper lubrication point with the proper amount of lubricant in the correct time interval is critical.

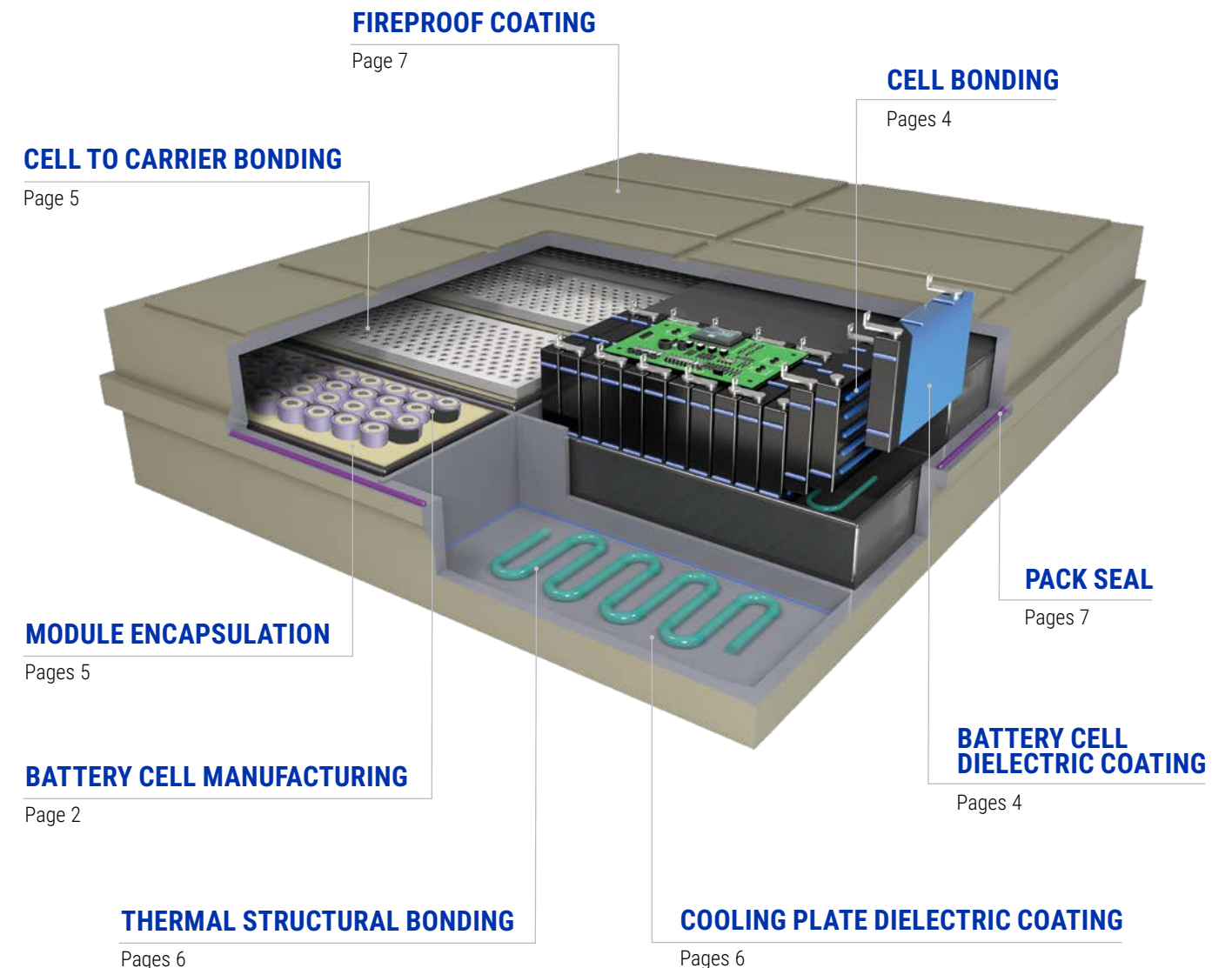
GRACO SOLUTIONS

Lubrication Pump: G-Mini

Divider Valve: CSP



MODULE AND PACK ASSEMBLY





MODULE APPLICATIONS

PRISMATIC CELL BONDING

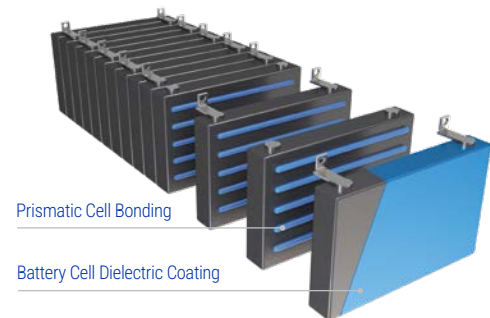
Prismatic cells are usually bonded with two-component polyurethane structural thermal pastes, which need to be light and flexible to allow the cells to expand during charging and discharging. To provide complete insulation and avoid short circuits, the application needs to be precise to avoid air gaps during the dispense.

GRACO SOLUTIONS

Supply Pumps: Check-Mate, E-Flo SP

Two-Component Systems: PR-X, PR-Xv, EFR, EVR

Two-Component Dispense Valves: MD2, TC Valve



BATTERY CELL DIELECTRIC COATING

As a key component of batteries, cells were formerly insulated using PET film (blue film). Nowadays, UV insulation spraying is gradually gaining attention due to its superior insulation performance, fast curing speed and environmental safety.

GRACO SOLUTIONS

Supply Pump: E-Flo DC

Metering Systems: ProMix Positive Metering (PD) Proportioning Platform

Guns: Stellair Air Spray Gun, PerformAA Auto Air-Assisted Gun, Pro XP Auto Electrostatic Gun

CELL-TO-FRAME BONDING

In many cases, modules are enclosed in a lightweight polycarbonate or acrylonitrile butadiene styrene (ABS) enclosure that is sealed closed. Cells are bonded with the frames around them to protect against outside contaminants. The sealing surfaces are generally very small and require precise bead dispensing.

GRACO SOLUTIONS

Ambient

Supply Pumps: Check-Mate, E-Flo SP

Two-Component Systems: PR-X, PR-Xv, EFR, EVR

Two-Component Dispense Valves: MD2, TC Valve

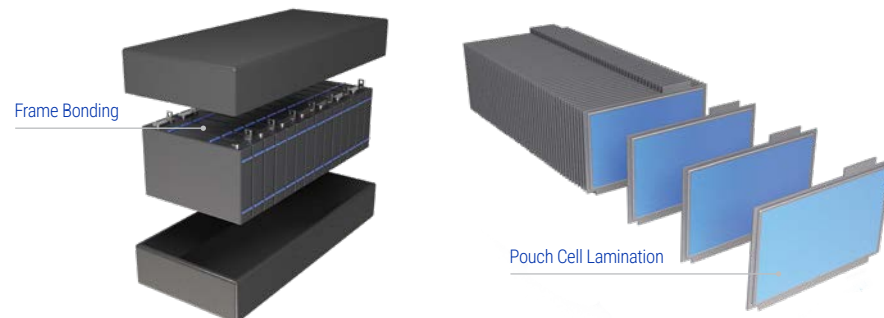
Heated

Supply Pump: Therm-O-Flow (heated)

Single-Component Metering Systems: PCF, PGM

Single-Component Orbital Dispense Valve: PrecisionSwirl

Single-Component Dispense Valves: iQ Valve, 1K Ultra-Lite, EnDure Valve



POUCH CELL LAMINATION

Hot melt pressure-sensitive adhesives are commonly used in pouch cell lamination to bond layers together. In cases where thermal conductivity is required, a silicone or polyurethane material may be used. These applications often require a precise spray or swirl pattern.

GRACO SOLUTIONS

Supply Pump: Therm-O-Flow (heated)

Single-Component Metering System: PCF

Single-Component Dispense Valves: iQ Valve, EnDure Valve

Two-Component System: HFR

Two-Component Dispense Valve: MD2

CELL-TO-CARRIER BONDING

Cylindrical cells are often bonded to a polycarbonate carrier during module assembly. This holds the cells stationary through the tab welding process and provides structural integrity to the module. A variety of adhesive chemistries can be used in this application including UV and two-component acrylics. Rapid precision dispensing is critical to this application.

GRACO SOLUTIONS

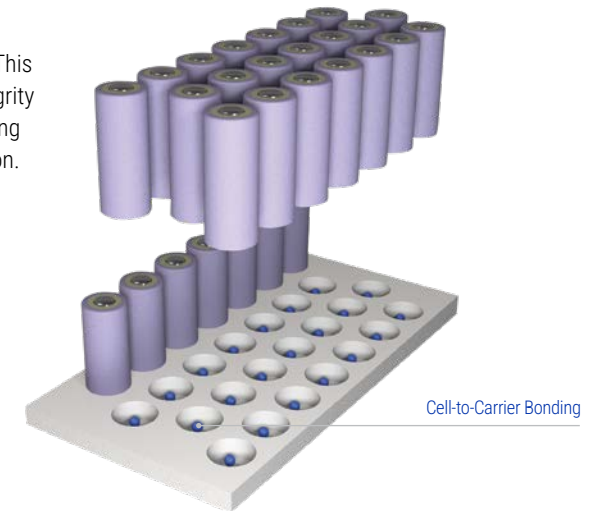
Supply Pumps: Check-Mate, E-Flo SP

Single-Component Metering Systems: PSM, PGM

Single-Component Dispense Valve: Advanjet Jet Valve

Two-Component System: PR-X, PR-Xv

Two-Component Dispense Valve: MD2, TC Valve



CYLINDRICAL CELL MODULE ENCAPSULATION

Module encapsulation, often used in cylindrical cell modules, provides for increased shock and vibration performance and is used to help prevent thermal runaway or propagation events within the modules. These materials are generally two-component polyurethanes or silicones that have a foaming reaction to create a lightweight buffer between the cells. This challenging application requires the right equipment and expertise as ratio, flow and mixing energy are all critical variables.

GRACO SOLUTIONS

Transfer and Transit Systems: Diaphragm Pump, T Pump, Graco Transit Tank

LowFlow Solution (<20 mL/s)

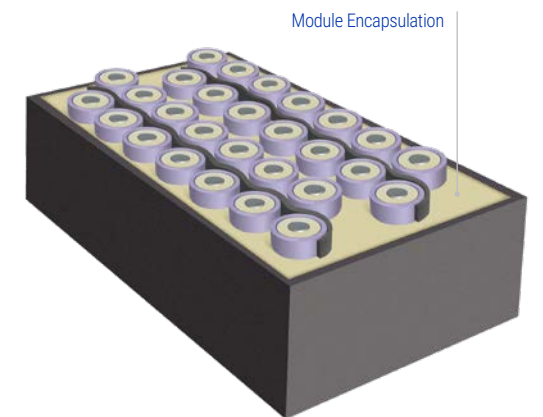
Two-Component System: EFR, EVR

Add MD2: Voltex

Medium to High-Flow Solution (20-220 mL/s)

Two-Component System: HFR NVH System

Guns: GX-16 Pour Gun, L Head Gun



POUCH CELL MODULE ENCAPSULATION

During the assembly of pouch cell modules, two-component non-foaming urethanes are usually used for encapsulation to improve the overall dependability of the cell modules.

GRACO SOLUTIONS

Supply Pumps: Check-Mate, Duro-flo

Two-Component Systems: EFR, EVR

Two-Component Dispense Valves: MD2, TC Valve



PACK ASSEMBLY APPLICATIONS

The assembly of battery packs includes applications to bond, fill, seal and coat. All of these applications contribute to guarantee strength, lightweight, proper heat management and protection against vibrations, shocks, water intrusion and outside contaminants.

COOLING PLATE DIELECTRIC COATING

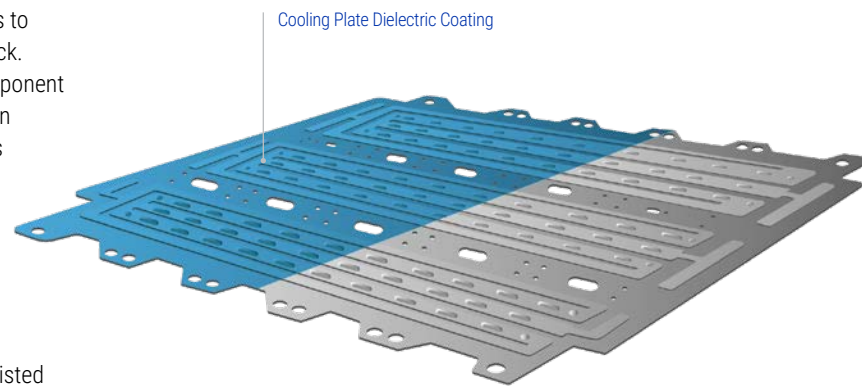
As an important part of the battery thermal management system, the cooling plates are insulated on their surfaces to ensure the overall insulation and safety of the battery pack. Compared to traditional powder spraying, the single-component dielectric coating is easier to rework with better insulation performance and lower energy consumption and enables battery lightweight with thinner film thickness.

GRACO SOLUTIONS

Supply Pump: E-Flo DC

Metering Systems: ProMix Positive Metering (PD) Proportioning Platform

Guns: Stellair Air Spray Gun, PerformAA Auto Air-Assisted Gun, Pro XP Auto Electrostatic Gun



THERMAL STRUCTURAL BONDING

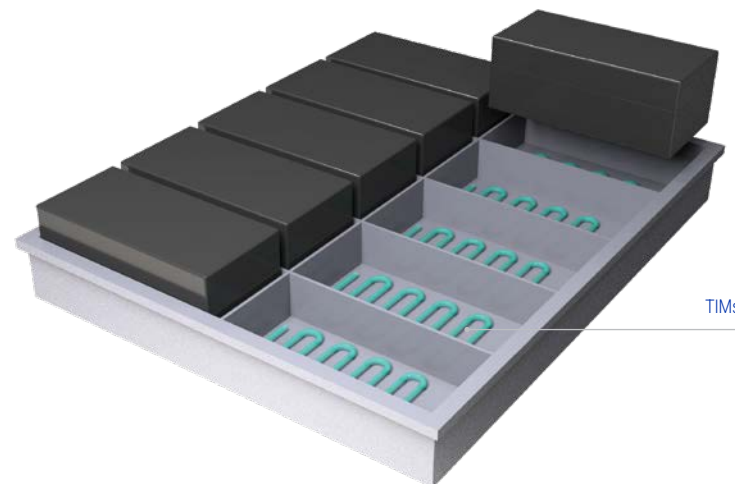
The performance of a battery is highly dependent on good thermal management. Thermal Interface Materials (TIMs) or thermal conductive adhesives (TCA) provide perfect thermal dissipation from the heated modules to the cooling circuits on the battery pack. These two-component TIMs are very viscous and abrasive to achieve ideal thermal conduction. This application often requires high-flow dispensing with robust pumping and precise metering, and air gaps must be avoided for optimal heat transfer. This application has many challenges and requires the right equipment that is made of abrasive resistant components to correctly handle these gap filler materials.

GRACO SOLUTIONS

Supply Pumps: Check-Mate, E-Flo SP

Two-Component Systems: EFR, EVR, HFR

Two-Component Dispense Valves: MD2, TC Valve, MDX



PACK SEAL

The pack seal is critical to the longevity and safety of a battery pack. The seals are often designed to an IP68 standard, which means that the seal will protect against water intrusions as well as outside contaminants. A variety of sealants can be used and fall into two categories – cure in place gaskets (CIPG) and form in place gaskets (FIPG). CIPG gaskets are dispensed and allowed to cure before assembly, creating a compression gasket in the pack seal joint. Alternatively, an FIPG gasket is dispensed, assembled immediately, and allowed to cure over time. In either case, precise and repeatable dispensing equipment is required for this critical seal.

GRACO SOLUTIONS

Ambient

Supply Pump: Check-Mate, E-Flo SP

Single-Component Metering System: E-Flo iQ

Single-Component Dispense Valve: iQ valve

Two-Component Systems: EFR, EVR

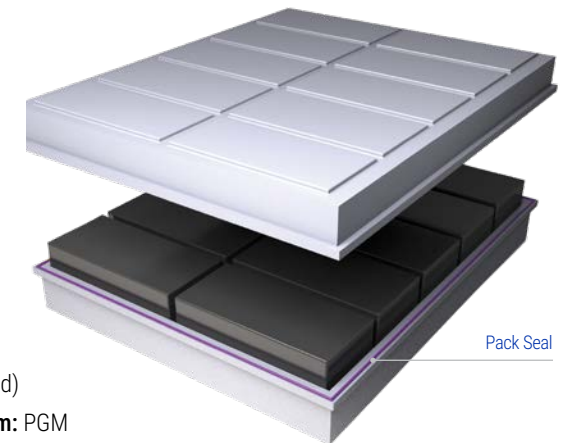
Two-Component Dispense Valves: Voltex, MD2, TC valve

Heated

Supply Pump: Therm-O-Flow (heated)

Single-Component Metering System: PGM

Single-Component Dispense Valve: EnDure Valve



FIREPROOF COATING

The cover of the battery pack can be applied with a fireproof coating that not only protects against fire but also protects against corrosion. As the coating is applied, its thickness must be consistent over the complete cover with as little over-applied as possible. It is therefore important to use equipment that can keep a constant and amLurate apply pattern.

GRACO SOLUTIONS

Single-Component Metering System: PCF

Single-Component Dispense Valve: Switch 3D Gun

Two-Component System: HFR

Two-Component Dispense Valve: Flat Stream Nozzle





OUR EQUIPMENT AND EXPERTISE

As a global leader in fluid handling equipment, Graco brings high-quality solutions to many industries, including automotive and battery. With years of experience, we offer tailor-made solutions that help you pump, meter, mix or dispense a wide range of adhesives, even highly abrasive Thermal Interface Materials (TIMs).

Whether your process requires minuscule drop dispensing or large-volume continuous flows, Graco has you covered.

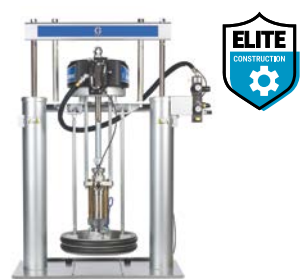
Graco supply pumps and dispense valves with Elite Construction are suitable for dispensing highly abrasive epoxy resin, silicone, Thermal Interface Materials (TIMs) and polyurethane. The Elite series products utilize abrasion-resistant seals and surface materials to deliver a service life at least 10 times that of equivalent equipment.



DISPENSING SYSTEMS

SUPPLY PUMPS

Pneumatic Driven	
Ambient	Heated Up to 400°F (204°C)



Check-Mate

For 20-liter to 200 liter pails



Therm-O-Flow

For 20-liter to 200 liter pails

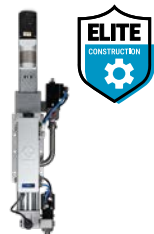
Electric Driven



E-Flo SP

For 20-liter to 200 liter pails

SINGLE-COMPONENT METERING SYSTEMS



Precision Shot Meter (PSM)

Shot Size Range: 0.005-100 mL

Flow Rate: 1.8 mL/sec - 18 mL/sec

Heated version brings the material temperature up to 70°C



Precision Continuous Flow (PCF)

Minimum shot size: 1mL

Continuous Flow Range: 6 mL/min - 22,500 mL/min



PGM

Continuous Flow Range: 30 mL/min - 1,600 mL/min

Heated version is available for hot melt applications

SINGLE-COMPONENT DISPENSE VALVES



Advanjet Jet Valve

Continuous flow valve for bead, dot and potting applications; ideal for micro-dispensing applications that need a shot size of 10 nl and above.

For low to high viscosities



PrecisionSwirl

Continuous flow valve for open or closed, wide or narrow-pattern beads

For low to medium viscosities



iQ Dispense Valve

Continuous flow valve for bead and dot applications

For medium to high viscosities

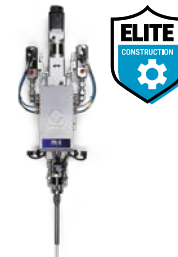


EnDure Valve

Continuous flow valve for bead and dot applications

For low to high viscosities

TWO-COMPONENT METERING, MIXING AND DISPENSING SYSTEMS



PR-X

Single Shot Size Range: 0.03 mL to 50 mL



EFR (Electric Driven)

Shot Size Range: 0.3 mL to any

Maximum Continuous Flow: 3,200 mL/min (207 bar)



HFR

Shot Size: over 30 mL

Maximum Continuous Flow: 19,000 mL/min



PR-Xv (Variable Ratio)

Single Shot Size Range: 0.03 mL to 100 mL

Ratio Range: 1:1 to 5:1 or 2:1 to 10:1



EVR (Electric Driven, Variable Ratio)

Shot Size Range: 0.3 mL to any size

Maximum Continuous Flow: 6,400 mL/min

Ratio Range: 1:1 to 5:1 or 2:1 to 10:1



HFR™-NVH

Shot Size: over 30 mL

Maximum Continuous Flow: 19,000 mL/min

TWO-COMPONENT DISPENSE VALVES



Vortex Dynamic Mix Valve

Ideal for bead and potting applications of foams



MD2

Ideal for low to medium-flow bead, dot and potting applications

Maximum flow rate: 75 mL/s (without snuff back)

For low to high viscosities



TC

Independent control for A/B component fluid paths; ideal for low to medium-flow bead, dot and potting applications

Maximum flow rate: 75 mL/s (without snuff back)

For low to high viscosities



MDX

High-flow bead, dot, and potting applications

Maximum flow rate: 150 mL/s

For low to high viscosities



OUR EQUIPMENT AND EXPERTISE

FINISHING SYSTEMS

SUPPLY PUMP



E-Flo DC

Ideal for dielectric coating applications

METERING SYSTEM



ProMix Positive Displacement (PD) Proportioner Platform

Ideal for dielectric coating applications

SPRAY GUNS



Stellair Auto Air Spray Gun



Pro XP Auto Electrostatic Gun



PerformAA Auto Air-Assist Gun

MATERIAL TRANSFER SOLUTIONS



**QUANTM
Electric Double Diaphragm Pump (EODD)**

Flow Rate: 30 gpm (114 lpm) - 120 gpm (450 lpm)

Pressure: 4 bar (60 psi, 0.4 MPa) -

7 bar (100 psi, 0.7 MPa)

220V Single phase, 380V three-phase



**Husky
Air Operated Double Diaphragm
Pump (AODD)**

Flow Rate: 50 gpm (189 lpm) - 250 gpm (950 lpm)

Pressure: 7 bar (100 psi, 0.7 MPa) -

8 bar (125 psi, 0.8 MPa)

MACHINE LUBRICATION SOLUTIONS

LUBRICATION PUMP



G-Mini

Delivers grease on-demand with scheduled intervals and precise volume. Features user-adjustable control and real-time alarm feedback.

DIVIDER VALVE

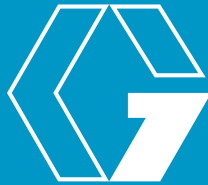


Compact Series Progressive (CSP)

Ensures precision grease metering for optimal lubrication distribution across all points



MOVING MATERIALS THAT MATTER™



For more information visit graco.com/evbattery

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