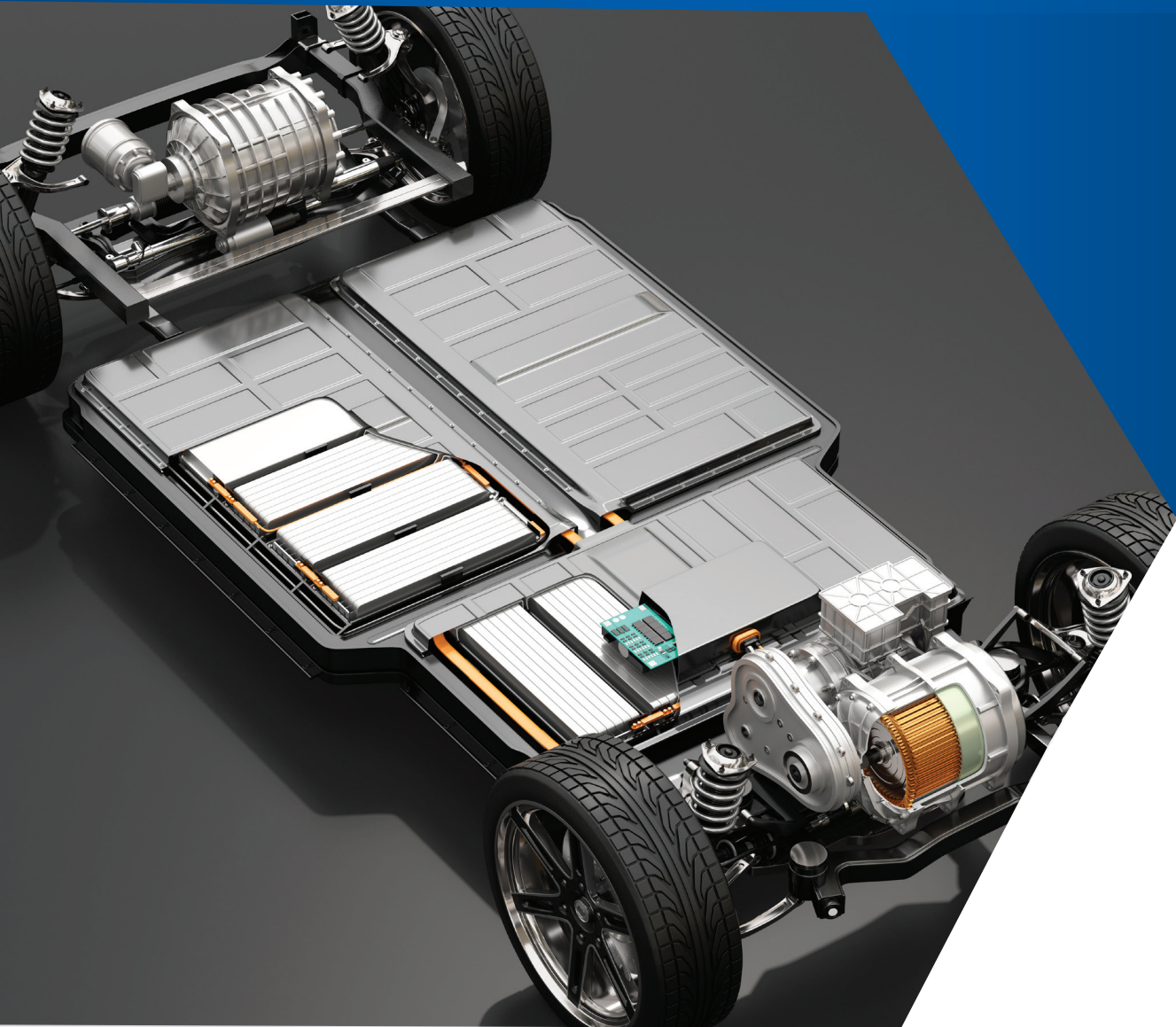


# SOLUTIONS FOR EV BATTERY ASSEMBLY

Bonding | Sealing | Coating | Thermal Management



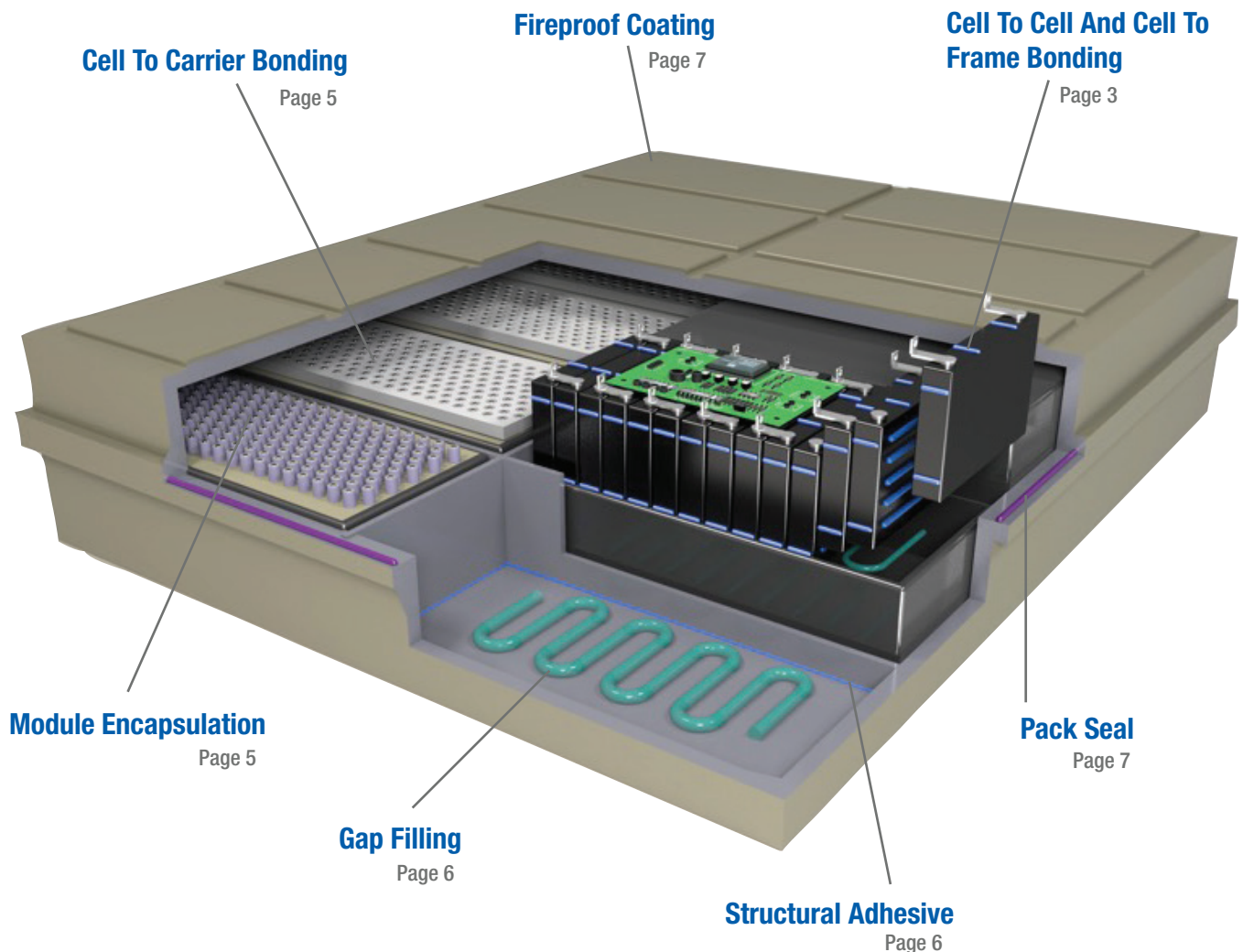
PROVEN QUALITY. LEADING TECHNOLOGY.

# 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. Adhesives, sealants, coatings and thermal interface materials (TIMs) are all important components of electrification and are enabling exciting design breakthroughs. These applications require robust dispensing solutions.

As you scale from prototype to mass manufacturing you need a partner you can count on. Graco is a leader in automotive and battery dispensing equipment. Our experts have vast experience in some of the most challenging applications. Count on us to get it right the first time.

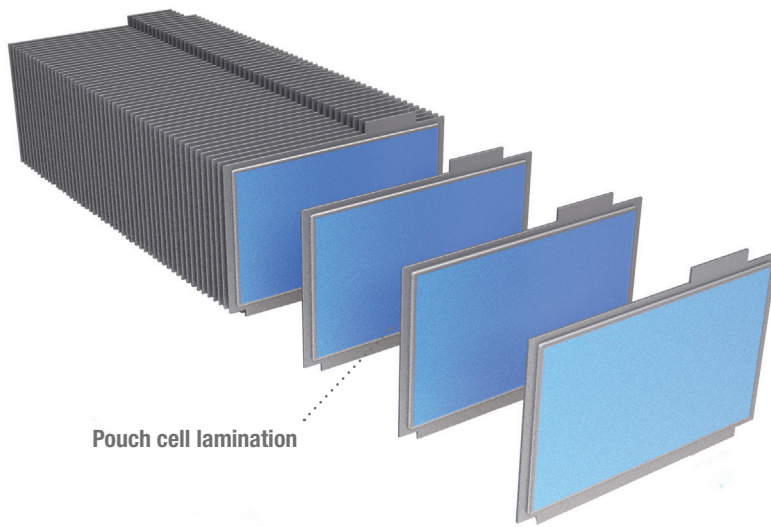


# Module Assembly Applications

The module assembly process depends on the cell format and the individual manufacturer designs. While pouch, prismatic, and cylindrical cell modules all have their unique design challenges, different sealing, bonding or TIMs applications are used to provide strength, protection and efficient heat dissipation.

## CELL TO CELL BONDING

Inside prismatic or pouch module designs, cells are firmly bonded to each other to create cells stacks and to provide insulation and protection against vibration or movement.



Pouch cell lamination

### 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.

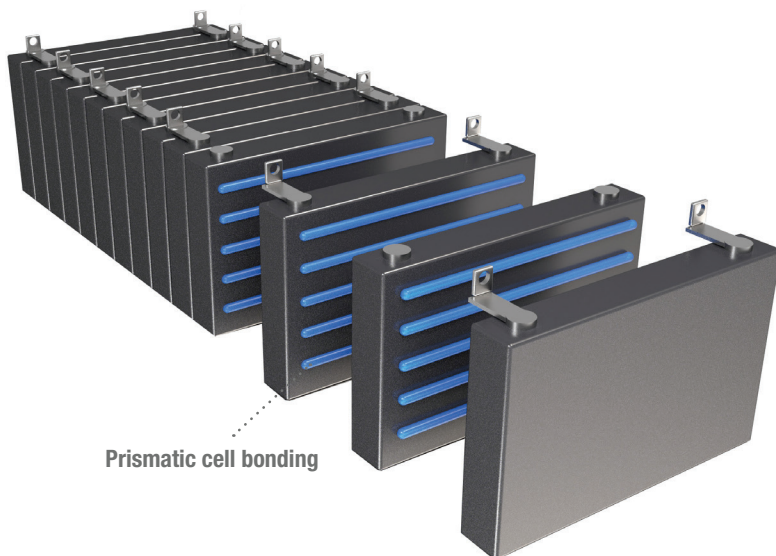
#### GRACO SOLUTIONS

**Supply Pump:** Therm-O-Flow (heated)

**One-Component Metering:** PCF

**Two-Component Systems:** PR70, EFR, HFR

**Valves:** PrecisionSwirl



Prismatic cell bonding

### Prismatic Cell Bonding

Prismatic cells are bonded with two-component urethanes or silicones 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

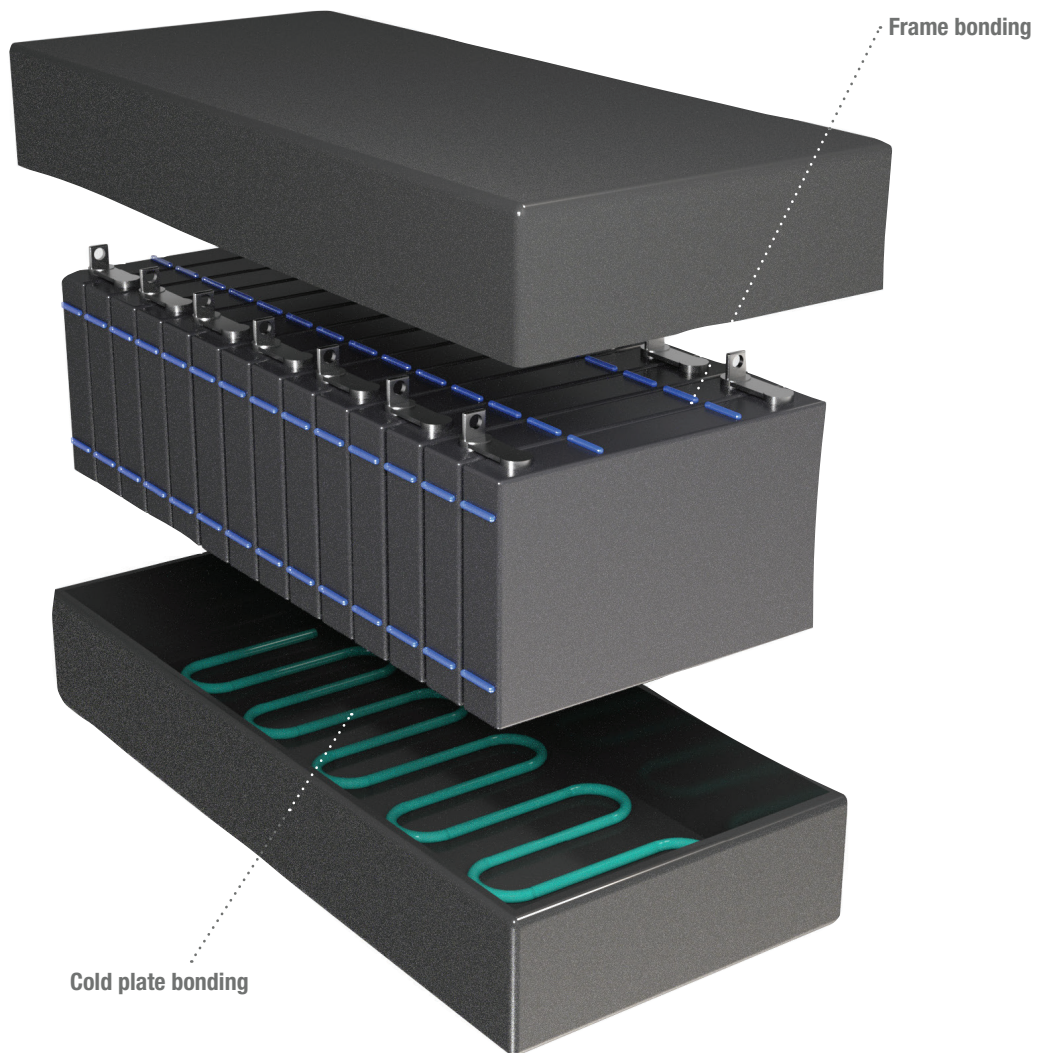
**Supply Pump:** Check-Mate, E-Flo SP

**Two-Component Systems:** PR70, PR-X, PD44

**Valves:** MD2

## CELL TO FRAME BONDING

In many cases, modules are enclosed in a lightweight polycarbonate or acrylonitrile butadiene styrene (ABS) enclosure that is sealed closed.



### Frame Bonding

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

**Supply Pump:** Check-Mate, E-Flo SP

**One-Component Metering:** PCF, Dispensit

**Two-Component Systems:** PR70, EFR, HFR

**Valves:** MD2, iQ Dispense Valve

### Cold Plate Bonding

Cold plate bonding involves bonding cells or other electronic devices to a cooling plate. This generally involves a structural bond that provides good thermal conductivity and dielectric strength. These materials are often abrasive and require the right dispensing solution. Two-component meter mix with precision control is of critical importance in these applications.

#### GRACO SOLUTIONS

**Supply Pump:** Check-Mate, E-Flo SP

**Two-Component Systems:** PR70, EFR, HFR

**Valves:** MD2, MDX

## 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.

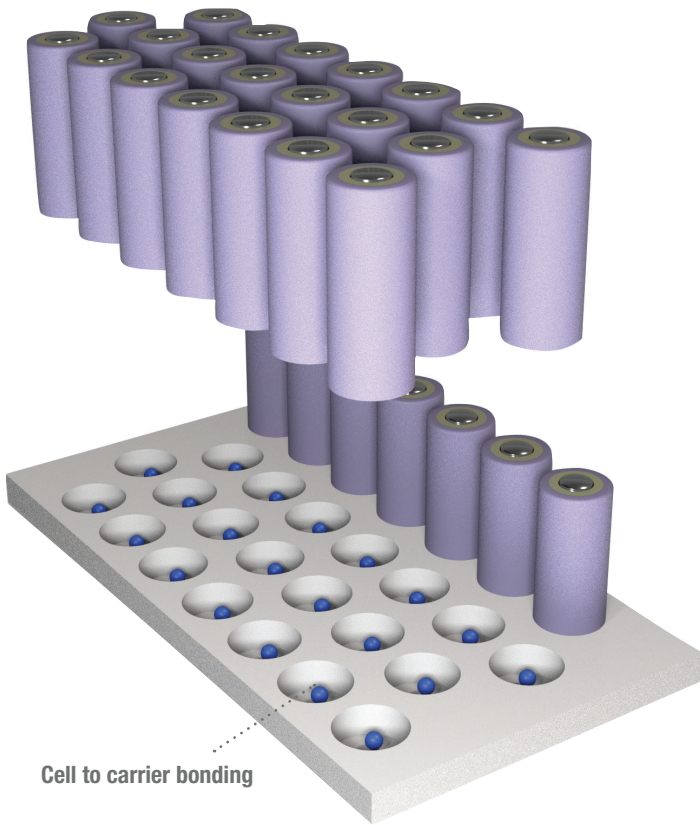
### GRACO SOLUTIONS

**Supply Pump:** Check-Mate, E-Flo SP

**One-Component Metering:** Dispensit

**Two-Component Systems:** PD44, PR-X, EFR, PR70

**Valves:** Advanjet



## MODULE ENCAPSULATION

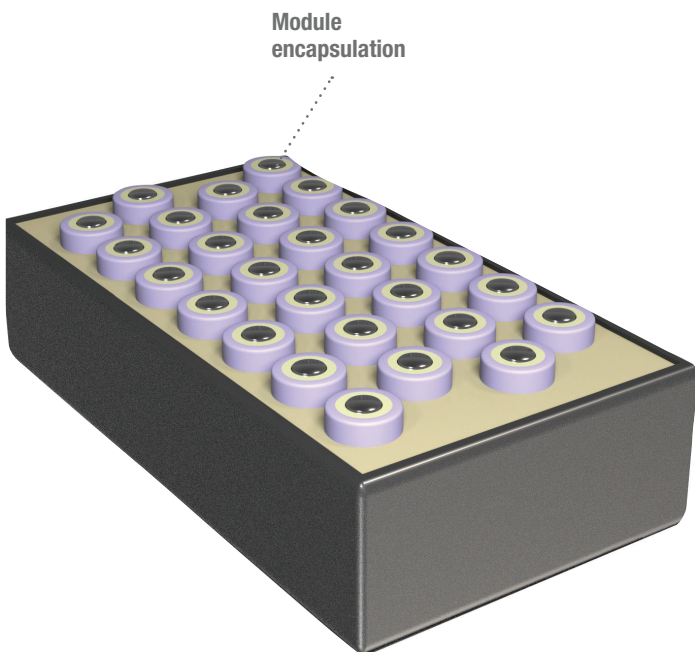
Module encapsulation, often used in cylindrical cell modules, provides for increased shock and vibration performance and is used to help prevent thermal runaway or propagation events within the modules. These materials are generally two-component polyurethanes, silicones or epoxies that have a foaming 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

**Supply Pump:** Check-Mate, E-Flo SP

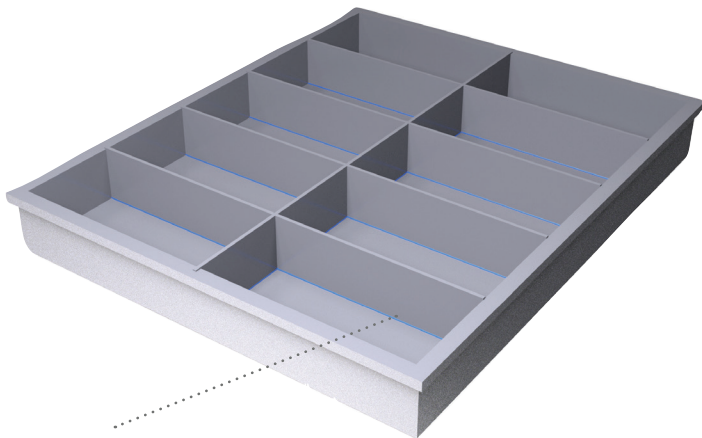
**Two-Component Systems:** PR70, EFR

**Valves:** Voltex, MD2



# 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.



Structural bonding

## STRUCTURAL BONDING

Structural bonding with one-component or two-component epoxies is done to bond aluminum or other materials within a battery pack. This not only contributes to the lightweight design but also offers extra strength and rigidity to the battery pack, which helps its crash-durability over the lifetime of the battery. Given the important nature of this application, the right equipment is a must.

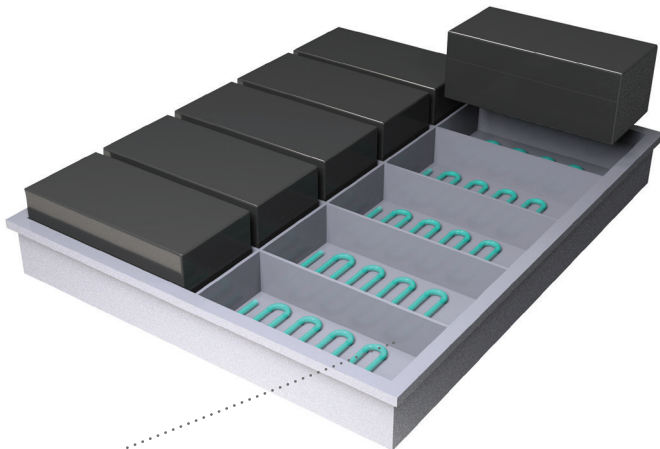
### GRACO SOLUTIONS

**Supply Pump:** Check-Mate, E-Flo SP

**One-Component Metering:** PCF, E-Flo iQ

**Two-Component Systems:** PR70, EFR, HFR

**Valves:** MD2, MDX, iQ Dispense Valve



Gap filling

## GAP FILLING

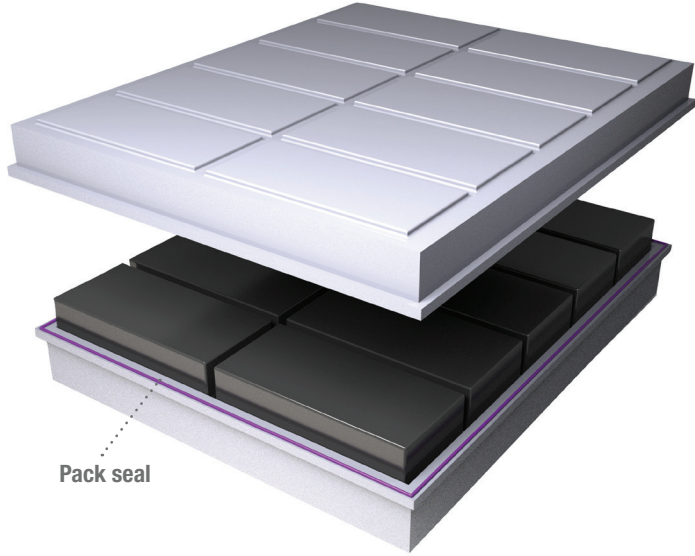
The performance of the battery is highly dependent on good thermal management. Thermal interface materials or gap fillers provide perfect thermal dissipation from the heated modules to the cooling circuits on the battery pack. These one and two-component gap fillers are generally non-structural but are very viscous with highly abrasive fillers which contain ideal heat conducting characteristics. The application often requires high flow dispensing with robust pumping, precise metering and dispensing, where air gaps must be avoided for an 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 Pump:** Check-Mate, E-Flo SP

**Two-Component Systems:** PR-X, EFR, HFR

**Valves:** MD2, 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

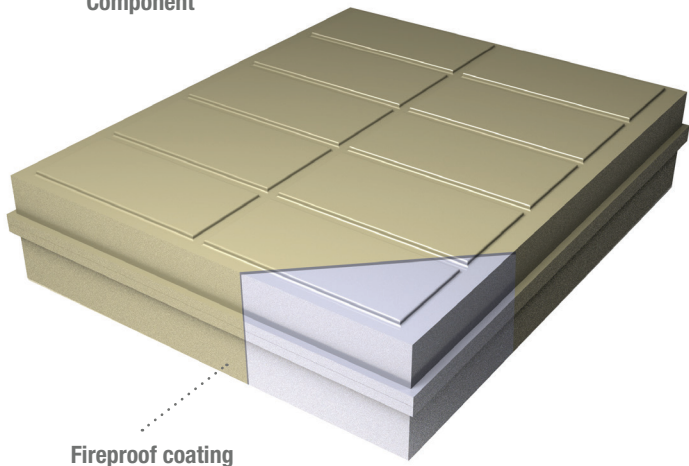
**Supply Pump:** Check-Mate, E-Flo SP

**One-Component Metering:** PCF, E-Flo iQ, PCP, Therm-O-Flow

**Two-Component Systems:** EFR

**Valves:** Voltex, EnDure, iQ Dispense Valve

Component



## FIREPROOF COATING

The cover of the battery pack can be sprayed 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 overspray as possible. It is therefore important to use equipment that can keep a constant and accurate spray pattern without overspray.

### GRACO SOLUTIONS

**Two-Component Systems:** Protector

# Our Equipment and Expertise

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 miniscule drop dispensing or large volume continuous flows, Graco has got you covered.

## ONE-COMPONENT SUPPLY PUMPS

### Pneumatic Driven

#### Ambient



#### Dynamite

For 300 cc cartridges – 1 gallon pails



#### Check-Mate

For 20 liter to 200 liter pails

#### Heated up to 400°F



#### Therm-O-Flow

For 20 liter to 200 liter pails

### Electric Driven



#### E-Flo SP

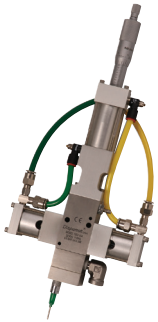
For 20 liter to 200 liter pails

Graco pumps and valves with Elite construction withstand the most abrasive epoxies, silicones, thermal interface materials (TIMs), and urethanes. With wear-resistant seals and surfaces, Elite can dispense at least 10 times more abrasive material than comparable equipment.





## ONE-COMPONENT METERING SYSTEMS



### Dispensit

Shot sizes from  
0.001 cc to 52 cc



### E-Flo iQ\*

Continuous flow 10cc/  
min-4500 cc/min



### Precision Continuous Flow (PCF)

Shot sizes down to 1cc or continuous  
flow from 6 cc to 22500 cc/min



### Progressive Cavity Pump\*

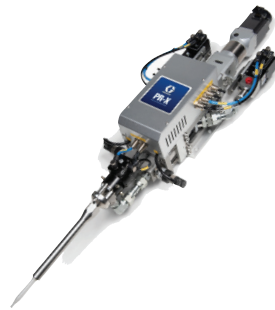
Continuous flow up to 87 cc/min

## TWO-COMPONENT METER, MIX & DISPENSE SYSTEMS\*



### PD44\*

Shot sizes from  
0.005 cc to 5 cc



### PR-X\*

For beads or dots from  
0.03 cc to 50 cc



### PR70

Shot sizes from  
0.005 cc to 5 cc



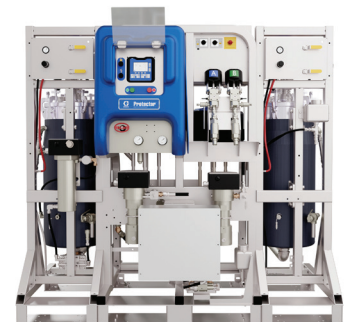
### EFR\* (electric driven)

Shots from 0.3 cc to any size or continuous  
flow up to 3200 cc/min at 207 bar



### HFR\*

Shot sizes above 30 cc or  
continuous flow up to 19000 cc/min



### Protector

Spray coating from  
1 liter to 11 liters per minute

\*Systems are available in different constructions to handle a wide range of adhesives, including high filled, high abrasive adhesives

## DISPENSE VALVES

### ONE-COMPONENT VALVES



#### Advanjet Jet Valve

Multitude of beads and dots for micro-dispense applications requiring 10nl drops and up.

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 dispense applications

For medium to high viscosities



#### EnDure

Continuous flow valve for bead and dot dispense applications

For low to high viscosities

### TWO-COMPONENT VALVES



#### Voltex

Dynamic mix valve for bead and potting applications of foams

For low viscosities



#### MD2

Dispense valve for a multitude of bead, dot and potting applications of 2.0 cc's and up

For low to high viscosities



#### MDX

Continuous flow valve for bead, dot and potting applications

For low to high viscosities

# Graco Has Got You Covered

## WORLDWIDE RESEARCH, DEVELOPMENT, AND CUSTOMER SUPPORT

For years Graco has been an expert in fluid handling equipment. With customer and innovation centres worldwide, we have been at the forefront of the research & development of various application solutions in industries like eMobility.

## SOLUTIONS & APPLICATION TIPS

Our expertise in core dispense technologies, including supply pumps, metering systems, and dispense valves, helping improve operational efficiency, product quality, and material application for our customers.

As we develop new products, we pay close attention to the quality and longevity of components, focusing on material application and compatibility and its impact on the product life cycle. Our commitment is to meet today's challenges and develop new solutions that will keep our customers at the forefront.

Whether you are looking to tackle application challenges or need help optimising your battery assembly processes, our team of engineers and application specialists will work together with you and material suppliers to find the right solution for your application.

## INNOVATION CENTER LOCATIONS



**GRACO - NORTH CANTON**  
8400 Port Jackson Avenue NW  
North Canton, OH 44720  
U.S.A.



**GRACO GERMANY - AACHEN**  
Nerscheider Weg 170  
52076 Aachen,  
Germany



**GRACO CHINA - DONGGUAN**  
Building 4  
No.14 Industrial South Road  
Songshan Lake High-tech Industrial  
Development Zone  
Dongguan, Guangdong 523808



[www.graco.com/evbattery](http://www.graco.com/evbattery)



## ABOUT GRACO

Founded in 1926, Graco is a world leader in fluid handling systems and components. Graco products move, measure, control, dispense and apply a wide range of fluids and viscous materials used in vehicle lubrication, commercial and industrial settings.

The company's success is based on its unwavering commitment to technical excellence, world-class manufacturing and unparalleled customer service. Working closely with qualified distributors, Graco offers systems, products and technology that set the quality standard in a wide range of fluid handling solutions. Graco provides equipment for spray finishing, protective coating, paint circulation, lubrication, and dispensing sealants and adhesives, along with power application equipment for the contractor industry. Graco's ongoing investment in fluid management and control will continue to provide innovative solutions to a diverse global market.

## GRACO LOCATIONS

### MAILING ADDRESS

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Fax: 612-623-6777

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Minneapolis, MN 55413

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Tel: 32 89 770 700

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Fax: 61 3 9468 8599

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Fax: 82 31 613 9801

## SALES/ DISTRIBUTION/ SERVICE

**877-84GRACO** (1-877-844-7226) or visit us at [www.graco.com/evbattery](http://www.graco.com/evbattery).

Graco Inc. is registered to I.S. EN ISO 9001

North America  
Customer Service  
800-328-0211  
Fax 877-340-6427