LITHIUM ION BATTERY APPLICATIONS

Enabling you to increase battery reliability, performance and yields
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Why Entegris?

For more than 40 years, many high-tech industries have relied on Entegris to ensure the safety and purity of their technologies throughout the supply chain, from the raw chemicals to the final products. A portfolio of more than 17,000 products offers you a reliable, single-source provider with global manufacturing, customer services and technical support. With a broad product offering, advanced manufacturing capabilities, worldwide infrastructure and unmatched technical expertise, Entegris provides proven performance, efficiency and reliability in your processes.

Broad Offering

Over the last 40 years, Entegris has developed a broad offering of high-purity materials, process control solutions and material handling to purify, protect and transport the critical materials that enable the world’s leading technologies. This experience offers you process solutions in contamination control, high-performance applications and product transportation requirements to meet your needs and provide a single source of flexible product offerings.

Mykrolis
2001 | Founded through Millipore spin-off
Liquid and Gas Purification, Contamination Control
2007 | Acquired Surmet Corporation’s high-purity semiconductor coatings business
High Purity and Specialty Coatings

Entegris
1999 | Founded through Fluoroware and EMPAK merger
Polymer Science, Process Knowledge
2005 | Entegris and Mykrolis merger
Materials Science
2008 | Acquired Poco Graphite
High Performance Graphite and Silicon Carbide

Millipore
1954 | Founded

Fluoroware
1966 | Founded
Fluid Handling

EMPAK
1981 | Founded
Wafer Handling


Company history

- **Millipore**
  - Founded 1954

- **Fluoroware**
  - Founded 1966
  - Fluid Handling

- **EMPAK**
  - Founded 1981
  - Wafer Handling

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  - Polymer Science, Process Knowledge

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  - Polymer Science, Process Knowledge
Experience You Can Count On

Contamination control is critical to your manufacturing processes and has a direct impact on production yields, productivity and the cost of manufacturing. Entegris focuses on understanding your processes, sources of contamination and on developing material-enabled solutions to ensure the cleanliness and integrity of your process.

To support your vital applications, Entegris utilizes more than 200 methods and applications, 300 analytical instruments and 17 collaborating laboratories focusing on separation and materials science to provide you with the highest-purity, quality and robust products.

Separation Science: Utilizing advanced knowledge in separation-science techniques to facilitate the separation, purification and analysis of complex mixtures of organic and inorganic compounds offers solutions to precisely control micro and molecular contamination. Incorporating these techniques into your process improves your manufacturing flexibility and decreases your costs, providing you with the highest level of contamination control.

Materials Science: By studying the characteristics and uses of high-performance materials such as polymers, metals, graphite, silicon carbide, coatings and carbon nanotube composites, we offer you high-quality products to improve performance, cost of ownership and your manufacturing yield. Sophisticated laboratory equipment and inspection techniques enable our scientists to thoroughly analyze materials for temperature capability, chemical compatibility, structural tolerance and maximum strength.

Proven Quality and Performance

With over 900 patents, Entegris works directly with you to develop process knowledge and products that enable innovation and efficiencies. Combining advanced engineering and design expertise with tools such as Finite Element Analysis (FEA), Computational Fluid Dynamics (CFD) and Moldflow® analysis and modeling enables us to optimize product design and speed technological advancements. In addition to innovative design, Entegris also utilizes R&D and quality lab analysis and testing capabilities to develop dependable solutions.

QUALITY TESTING
- Vibration and shock
- Safety and industry standardization
- Trace metals
- Electrostatic charge

PERFORMANCE TESTING
- Particle testing
- Flow rate optimization
- Ion chromatography
- Failure analysis

Ensuring product performance standards are met, proven techniques such as ISO 9001 certified manufacturing sites, documentation control, Lean Sigma processes and quality testing are utilized. Each manufacturing capability has been developed, tested and improved to create pure, durable, consistent and reliable products.

- Injection molding
- Rotational molding
- Blowmolding
- Extrusion
- Machining
- Welding and flaring
- Sheetlining
- Overmolding
- Prototyping
- Tool design/making
Our global direct sales team, sales channel partners and local applications engineers give you the support and expertise when you need it. This intimacy allows us to better understand your needs through direct feedback and roadmap sharing. By aligning our materials science, engineering and R&D initiatives, we can develop indispensable contamination control and high-performance solutions to solve your roadmap challenges.

You'll receive strong technical support and training from our local service groups and engineers consisting of field applications engineers, technical service groups and applications development groups. Our global field applications engineers work directly with you on product qualification and process improvements in your facilities. Also, in response to your needs for local technical service and fast turnaround time, we maintain regional applications laboratories. These applications laboratories maintain process equipment that simulate your applications and provide product evaluation.
Entegris in Lithium Ion Battery Applications

From reducing dendrites in cell manufacturing to removing moisture during electrode formation, you rely on application and technology expertise from your suppliers. Whether utilizing our contamination control knowledge in working with the leading original equipment manufacturers or developing innovative high-performance technologies, Entegris provides proven performance, efficiency and reliability in your processes.

| Cell Manufacturing Assembly | Mixing  
|                           | Coating  
|                           | Electrolyte Filling and Sealing |
| Electrode Formation        | Mixing  
|                           | Coating  |
| Electrolyte Manufacturing  | Gas and Chemical Delivery  
|                           | Mixing  
|                           | Storage and Packaging |
Your processes require optimum material handling and contamination control to achieve target cell capabilities. Today’s growing lithium ion battery products demand technologies and production processes that lower operating costs while improving battery quality. However, these higher quality batteries require production in a safe, efficient and flexible working environment. All the technologies utilized, from mixing and coating to packaging, ultimately have a direct impact on the quality and lifetime of these cells.

In the electrolyte fill process, moisture causes a build-up of issues starting with hydrofluoric acid (HF) contamination in all lithium hexafluorophosphate (LiPF₆) based electrolytes. At the beginning of the process, the typically nitrogen, pressurized gas system that transports the electrolyte from a stainless steel vessel to the equipment’s electrolyte reservoir requires the lowest moisture levels possible. If moisture is present, the created HF attacks the stainless steel reservoir, pipes and connections, causing metallic ion leaching in the form of Fe, Ni, Cr, Cu, Mg and Mn into the electrolyte. These metal ions combine with a host anion and, under the right conditions, form a solid particulate. Moisture, particulates and metallic contamination cause dendritic growth, which affects the battery cells’ performance and safety.

Entegris provides a broad portfolio of high-performance contamination control technologies designed to enhance the purity of your raw materials and reliability in chemical distribution. Entegris solutions ensure the integrity of your chemicals and allow manufacturing of batteries to your highest performance specifications, while providing improved battery reliability and performance with contamination control to the ppm and ppb levels.
Gas Filtration
To improve or maintain critical gas specifications in clean dry air (CDA) or other gases, as well as minimize any particulate contamination, Entegris provides gas filtration for a wide range of applications including point-of-use (POU) and bulk supply. These technologies reduce your particle and organic contamination from source chemicals and distribution piping. Wafergard® and Linegard™ gas filters offer flow options greater than 1,000 SLPM with a very low differential pressure, small footprint options and a removal rating of ≥0.003 µm.

Liquid Filtration
Process chemistries vary and the appropriate filtration technology needs to be applied to achieve the most efficient and cost-effective solution. With over 40 years of experience in filtration, Entegris offers a wide range of filtration technologies and products which are designed to meet the needs for all these chemistries. These filters offer particle reduction from electrolyte source chemicals at POU, electrolyte fill machine, slurry mixing tank, coating tool and distribution piping, all designed to enhance your process control.

Gas Purification
In your electrolyte fill-tool delivery system or fill-pouch delivery system, decreasing moisture levels in the N₂ push or blanket gas is essential. Entegris offers high-performance purification components designed to meet your various process requirements, such as the elimination of both particle and molecular contamination (e.g., moisture and CO₂) from process gases. By reducing dry-room operational costs, Entegris CDA purifiers offer control of the surrounding atmosphere to ppt moisture levels. Entegris purifiers are capable of removing contamination down to the ppt level and achieving an over -100°C dew point.

Liquid Purification
Cell manufacturing requires high-performance contamination control technologies for the purity of raw materials and reliability in your chemical distribution. For the reduction of dendrite formation, Protego® liquid purifiers decrease metal ion contamination in solvents (e.g., NMP and deionized water [DI]), while H₂O purifiers remove moisture to provide high removal and capacity rates for ultimate protection and long life.

Chemical Delivery
Chemicals, while pure when delivered, may become contaminated by process components as they are transported to and through the process tool. It is important that the correct components are selected to optimize chemical compatibility and function with other process variables such as pressure drop and operating temperatures. From perfluoroalkoxy (PFA) tubing, fittings and pressure transducers to flowmeters, Entegris offers the highest-purity, best-performing fluid handling components available to meet these challenges and eliminate process fluid contact with metals.
Electrode formation is a critical component of lithium ion battery manufacturing. Materials for both the anode and cathode need to be prepared or mixed to obtain the optimum chemical ratios and deliver contamination-free materials throughout the web coating process. Contamination that originates from the constituents or is introduced during transport becomes destructive to the performance and lifetime of the cell. In particular, metal contamination can become free of the electrode after the electrolytes are introduced into the manufactured cell. Even small, dissolved ionic quantities can form dendritic bridges, which cause poor cell performance or failure. In addition, moisture causes nonuniform coating of the electrodes and results in lost performance and reliability.

Today’s processes require optimum material handling and contamination control to achieve target cell specifications. These requirements will only become more stringent with next-generation cells with higher-power densities. In addition, delivery of the chemicals to the process require components in the fluid path that are both compatible with the chemistries and do not add contaminants. Metal components in the delivery system can wear from the slurries and become sources of metallic contamination. Entegris Cynergy® PFA fluid handling components eliminate this source of contamination.

Finally, both incoming chemical impurities, as well as contaminants introduced during the mixing and coating processes, need to be reduced to acceptable levels with appropriate filtration and purification technologies. Entegris offers a full range of material handling and contamination control products to meet these challenging demands, while meeting critical cost of ownership needs.
Gas Filtration

To improve or maintain critical gas specifications in CDA or other gases, as well as minimize any particulate contamination, Entegris provides gas filtration for a wide range of applications including POU and bulk supply. These technologies reduce your particle and organic contamination from source chemicals and distribution piping. Wafergard and Linegard gas filters offer flow options greater than 1,000 SLPM with a very low differential pressure, small footprint options and a removal rating of ≥0.003 µm.

Liquid Filtration

Process chemistries vary and the appropriate filtration technology needs to be applied to achieve the most efficient and cost-effective solution. With over 40 years of experience in filtration, Entegris offers a wide range of filtration technologies and products which are designed to meet the needs for all these chemistries. These filters offer particle reduction from electrolyte source chemicals at POU, electrolyte fill machine, slurry mixing tank, coating tool and distribution piping, all designed to enhance your process control.

Gas Purification

In your electrolyte fill-tool delivery system or fill-pouch delivery system, decreasing moisture levels in the N₂ push or blanket gas is essential. Entegris offers high-performance purification components designed to meet your various process requirements, such as the elimination of both particle and molecular contamination (e.g., moisture and CO₂) from process gases. By reducing dry-room operational costs, Entegris CDA purifiers offer control of the surrounding atmosphere to ppb moisture levels. Entegris purifiers are capable of removing contamination down to the ppt level and achieving an over -100°C dew point.

Liquid Purification

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Chemical Delivery

Chemicals, while pure when delivered, may become contaminated by process components as they are transported to and through the process tool. It is important that the correct components are selected to optimize chemical compatibility and function with other process variables such as pressure drop and operating temperatures. From PFA tubing, fittings and pressure transducers to flowmeters, Entegris offers the highest-purity, best-performing fluid handling components available to meet these challenges and eliminate process fluid contact with metals. Entegris addresses these issues with the Cynergy, PFA fluid handling family of products. Cynergy utilizes industry-standard sanitary connections and offers line sizes from ¼” to 2”, as well as sweep elbows and customized fitting capabilities. The Cynergy PFA line of fluid handling components eliminates the occurrence of metallic particles from sidewall abrasion, as occurs with stainless steel piping. In addition, they reduce pressure drop due to lower friction loss, reduce cleanup time and are translucent, allowing for visual confirmation of fluid flow.
In electric vehicle applications, lithium ion battery performance and reliability are among your customers’ highest process concerns. In the cell manufacturing process, high-purity electrolytes are a core component of the lithium ion battery manufacturing process. In the attempt to prevent dendritic formation and degradation of the solution, some specific additives utilized in electrolyte production may impact battery performance factors such as thermal and hydrolytic stability, high conductivity and discharge rates, among others. Additionally, moisture contamination in your high-purity process will hydrolyze the LiPF$_6$ in electrolytes and form corrosive HF. When HF comes in contact with metal, it forms metallic ions which can promote dendritic formation in the LiB cell. For this reason, it is important to minimize electrolyte liquid contact with stainless steel vessels, piping and connections. Entegris understands avoiding moisture contamination is an important challenge when transferring electrolyte using dry nitrogen gas streams and when utilizing a nitrogen blanket over the mix process. If moisture is present, the created HF attacks the stainless steel components causing metallic ion leaching in the form of Fe, Ni, Cr, Cu, Mg and Mn into the electrolyte. Moisture, particulates and metallic contamination cause dendritic growth with deleterious effects to the battery cells’ performance and safety.

Entegris provides a portfolio of high-performance contamination control technologies for the filtration and purification of raw materials to the ppm and ppb purity levels. These solutions ensure the integrity of your chemicals, meet your cost of ownership needs and allow electrolyte manufacturing to the highest performance specifications.

In addition, Entegris supplies high-density polyethylene (HDPE) containers, as well as PFA-lined pressure vessels with polyethylene (PE) overpack and stainless steel (SS) overpack, which are available in numerous sizes. Customizable PFA dip tubes are also available. These containers and dip tubes eliminate the metal contact of the electrolyte with SS vessels, as is the common practice.
Gas Filtration
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Discover Contamination Control Down to the ppm Level

Delivering proven knowledge in materials science and contamination control, Entegris improves battery reliability, ensures the integrity of your chemicals and allows you to manufacture batteries to your highest performance specifications.

- Chemical Delivery
- Purification/Filtration
- Process Control
- Chemical Packaging

For More Information

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