

Integrated

Turnkey Coating, Drying
& Solvent Recovery

Solutions

for Battery Electrode Production



MEGTEC is a fully integrated global design, engineering, manufacturing and services company providing industrial equipment and services to various industries including lithium-ion and other advanced battery materials, solar films, membranes, automotive, engineered wood products, printing, chemical, electronics and other process industries.

Working with companies in the U.S., Europe and Asia for the production of anode and cathode electrodes, MEGTEC is leading the process development of advanced batteries with custom coating, drying and solvent recovery equipment for the advanced battery manufacturing process.



At the core of MEGTEC's history as the recognized leader in providing drying and environmental solutions for web coating, is its 40+ years of experience, more than 100 patents, and thousands of installations worldwide:

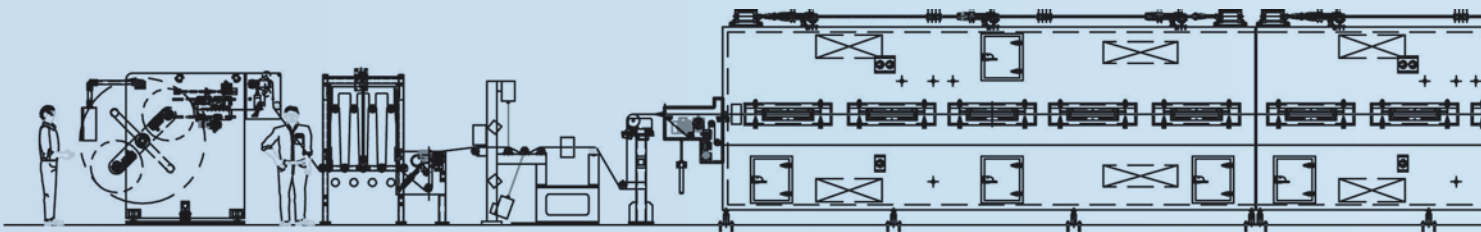
- ✓ Web Handling
- ✓ Heat Transfer
- ✓ Air Distribution
- ✓ Environmental Solutions



MEGTEC has the knowledge and experience to provide a complete turnkey approach for the production of lithium-ion battery cathode and anode electrode materials. Whether you are looking for a "state-of-the-art" solution or one that will meet your basic needs as a new player to the market, MEGTEC offers a one-stop solution for your electrode production needs - a solution that includes turnkey coating line with equipment installation, start-up supervision and 24/7 service and parts support.

Benefits:

- Uniform coating, drying and curing to meet demands for superior quality
- Stable web handling for thin substrates and heavy coat weights
- Single-side or simultaneous two-side coating and drying to allow for efficient utilization of spaces and available resources
- Lane and skip coating for all battery configurations
- Single or multi-level line configurations
- Coating thickness/coat weight measurement and closed-loop control to the coater/fluid delivery system for continuous quality and documentation



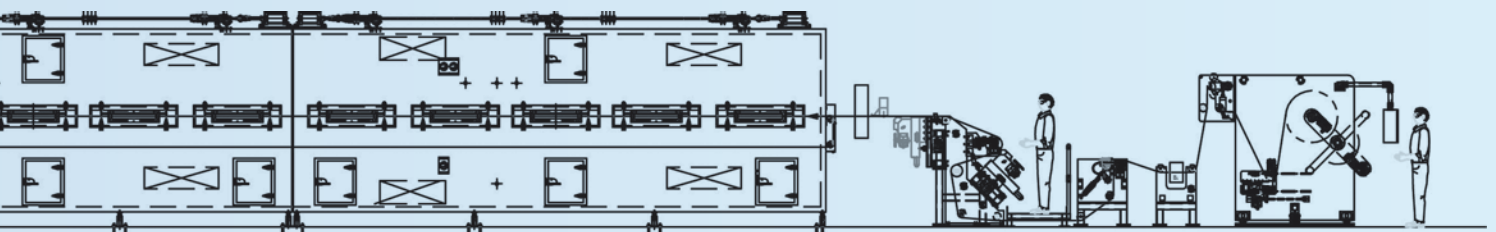
Complete Solutions for Electrode Production of Advanced Batteries

MEGTEC provides complete turnkey solutions for the production of advanced web-based materials including raw material handling, coating/slurry mixing and fluid delivery, web handling, coating and drying, solvent recovery and purification, calendering and slitting.



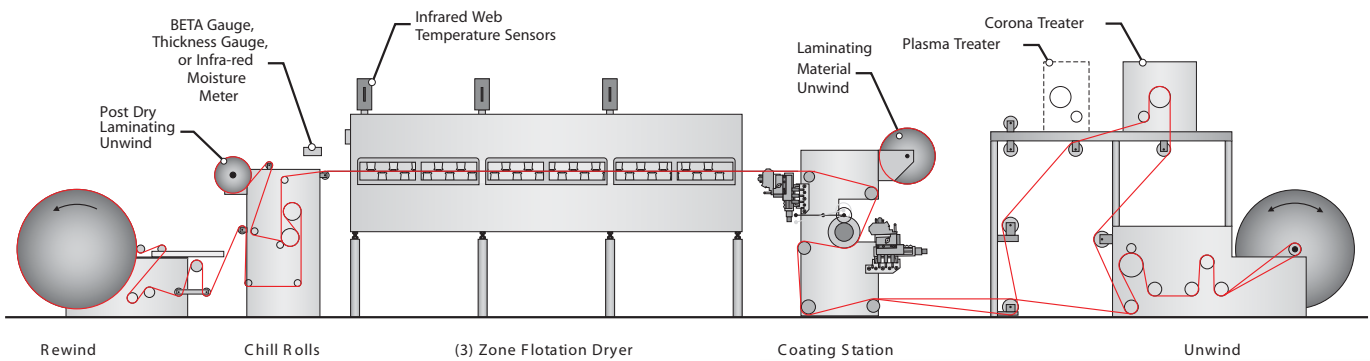
MEGTEC's scope of supply for battery electrode coating lines includes:

- Raw material/powder storage and handling systems
- Coating/slurry mixing and fluid delivery systems
- Web handling components including: unwind, pull rolls, tension control, web guiding and rewinds
- Coater (1 or 2 side)
- Multi-zone drying systems
- Vision, defect detection and defect marking systems
- Coating thickness and coat weight measurement and control systems
- Solvent recovery, purification and emission control systems
- Slitting
- Calendering
- Complete PLC-based control system, line drives integration of all unit operations via a SCADA supervisory system
- Options to meet various classifications of clean room requirements

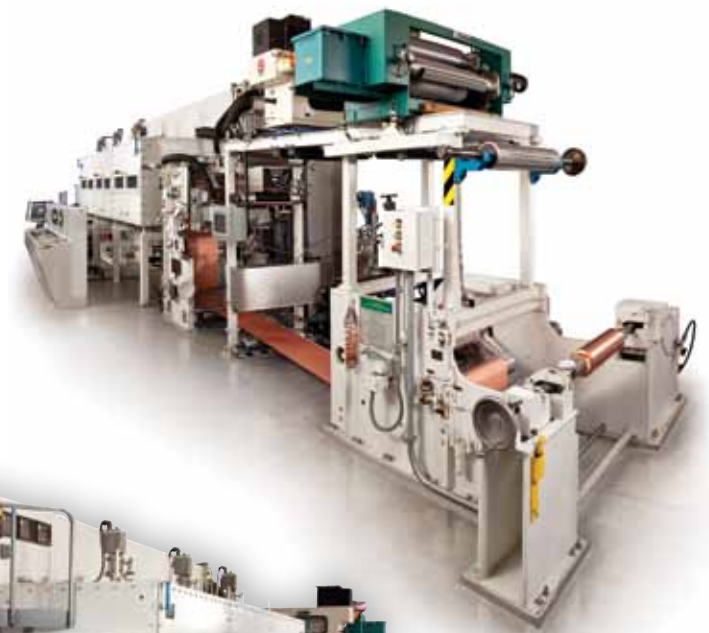


Research & Development Center

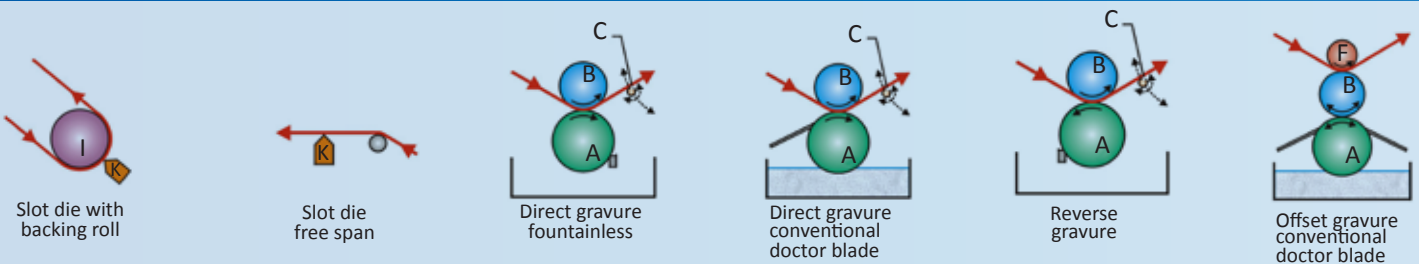
MEGTEC's R&D Center in De Pere, Wisconsin enables customers to facilitate their ideas and innovations into advanced technology patents.



- Slot die coater with skip and stripe coating capabilities
- (3) 1.5m dryer zones for wide range of web widths, substrates, tensions
- Web widths up to 400 mm
- Laminator, both wet and dry end
- Corona and plasma treater
- High performance fluid delivery system
- Ross dispersing mixer
- Thickness gauges



Slot die coating is the preferred coater method for the production of advanced battery electrodes.



The MEGTEC R&D Center located in our De Pere, Wisconsin, USA facility includes an in-house pilot lab line that offers mixing capabilities for preparation of slurry mixtures, multiple coating methods, a 3-zone dryer that can be used with a wide range of substrates and tensions, plasma and corona treater for foil substrates, and on-line coating thickness measurement and tracking.

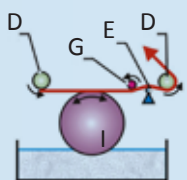
Using MEGTEC's pilot coating line can help you conduct proprietary research and development, test and optimize new or existing coatings, web materials and processes. By using the pilot coater facilities, you avoid expenditures of overhead, capital equipment and start-up costs while developing new products. MEGTEC's pilot line provides the versatility and confidentiality you need, as well as the ability to produce prototype materials for further research, marketing and quality testing.



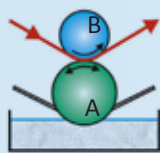
Electrode production on MEGTEC's pilot coater.



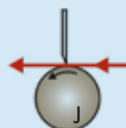
In-house capability to mix coatings with dispersion blade and anchor agitator.



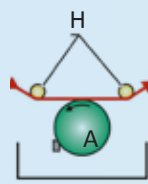
Meyer rod



Reverse angle doctor blade



Knife over roll



Reverse gravure kiss wrap

- A. Gravure roll
- B. Elastomer covered roll
- C. Smoothing bar
- D. Idler roll
- E. Meyer rod
- F. Steel backing roll

- G. Intermediate idle
- H. Kiss rolls
- I. Smooth chrome roll
- J. Aluminum backing roll
- K. Slot die

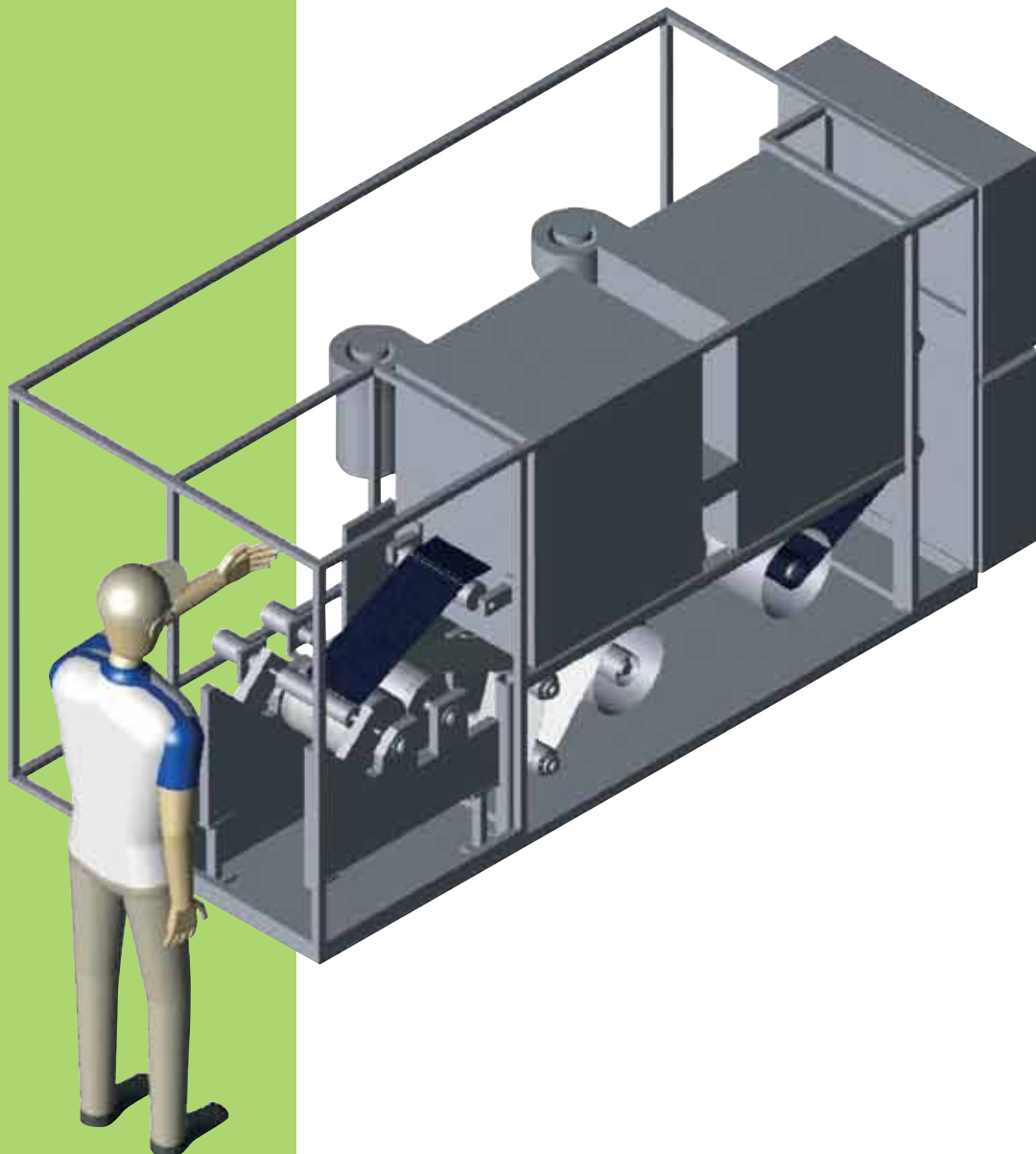
Laboratory Coating Line for Lithium-ion Advanced Batteries

- ✓ Modular
- ✓ Compact
- ✓ Easy to Use
- ✓ Multiple Coating Methods Available

MEGTEC has developed an easy-to-use laboratory coating line designed for short production runs. Developed specifically for companies who are involved in the development and testing of lithium-ion, lithium sulfur and silver zinc battery coating formulations, MEGTEC's coating line offers the capability of producing 200 mm wide cathode and anode samples at speeds up to 3 meters/minute.

The coating line consists of the following equipment:

- Cantilevered unwind and winder
- Precision coating module with comma coater or slot die coater
- Convection dryer with either impingement or flotation nozzles to dry the coated side of the web
- Modular, one-piece design requires minimal space for easy installation in a laboratory environment
- Approximate footprint 4500 mm long x 1100 mm wide x 2000 mm high



Aftermarket Services

Upgrades, Rebuilds, System Integration & Field Services

MEGTEC offers Aftermarket Services, Upgrades, Rebuilds, System Integration, and Field Services for the complete coating line including: web conveyance, coater, dryer, and solvent recovery system or oxidizer.

- Existing equipment capability and process evaluation
- Line speed upgrades and system expansion
- Installation and commissioning of web treatment systems, measurement systems, web handling, and auxiliaries
- Web path modifications including backing roll and idler roll upgrades
- Addition or upgrade of drying zones including air bars/ nozzles and heat sources
- Air flow balancing, drying efficiency and exhaust reduction
- Optimization of air flows, temperature/pressure controls, tension controls, roller alignment, and vibration analysis
- Retrofitting complementary post-treatment process equipment
- Replacement reboilers & heat exchangers
- Replacement distillation column trays & packing material
- Equipment relocation



Electrical and controls upgrades and retrofits:

- Equipment integration
- Instrumentation and calibration
- PLCs, variable frequency drives, operator interfaces
- Air flow/temperature/pressure controls, burner management, fuel trains
- Continuous emission monitoring systems
- Remote monitoring capabilities

MEGTEC provides factory-trained Field and Preventive Maintenance Services to ensure your equipment is running at peak performance.

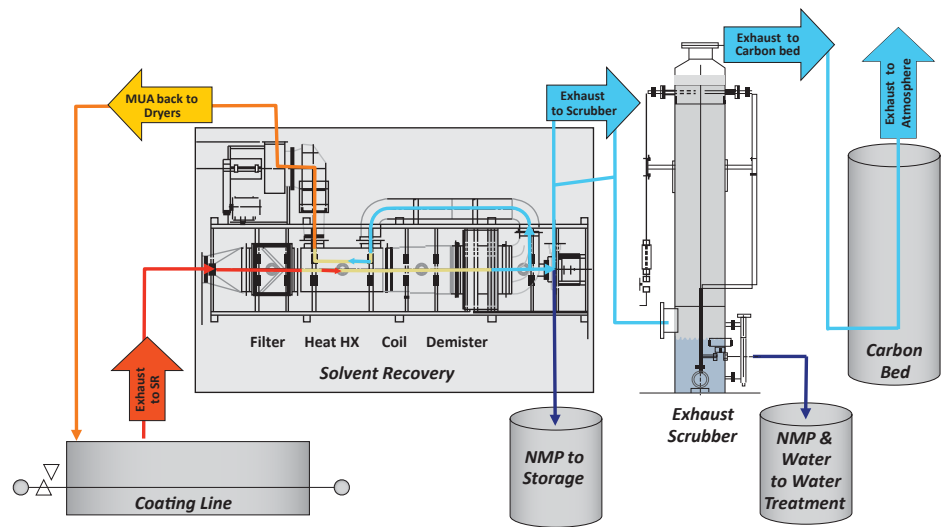
- **Field Services providing onsite troubleshooting or remote monitoring**
- **Preventive Maintenance including annual service and maintenance plans**
- **Sampling and testing services**
- **Spares/replacement parts**
- **Start-up and installation services**
- **24/7 Service and parts**

Air Pollution Control by Solvent Recovery / Carbon Adsorption

MEGTEC has developed proprietary systems for high efficiency removal, recovery and purification of N-Methylpyrrolidone (NMP) and N-Ethylpyrrolidone (NEP) from coating line exhaust air streams in the lithium-ion battery electrode manufacturing process. These systems can be configured to provide regulatory compliance with global and local emission standards.

MEGTEC's Solution:

To achieve a high rate of recovery with minimum operating costs, MEGTEC utilizes a combination of proven technologies as part of the recovery process. A simplified flow diagram follows:



- The process is a closed-loop system. The exhaust air stream from the dryer is first pre-cooled via heat exchange with the dryer exhaust that is returned to the dryer as make-up air
- NMP solvent is recovered from the exhaust stream via chilled water condensation
- The exhaust air stream is reheated via heat exchange with the dryer exhaust and is returned to the dryer as make-up air
- A small slip-stream resulting from the infiltration into the dryers is sent to a water scrubber prior to being discharged to the atmosphere
- The liquid NMP solvent is recovered and is sent to a distillation system for dehydration and purification or to off-site processing

Solvent Recovery

The MEGTEC solution utilizes chilled water condensation of NMP or NEP as the primary means of recovery. A water scrubber provides a secondary means of lowering the NMP or NEP concentration in the exhaust stream to acceptable levels that meet environmental requirements.

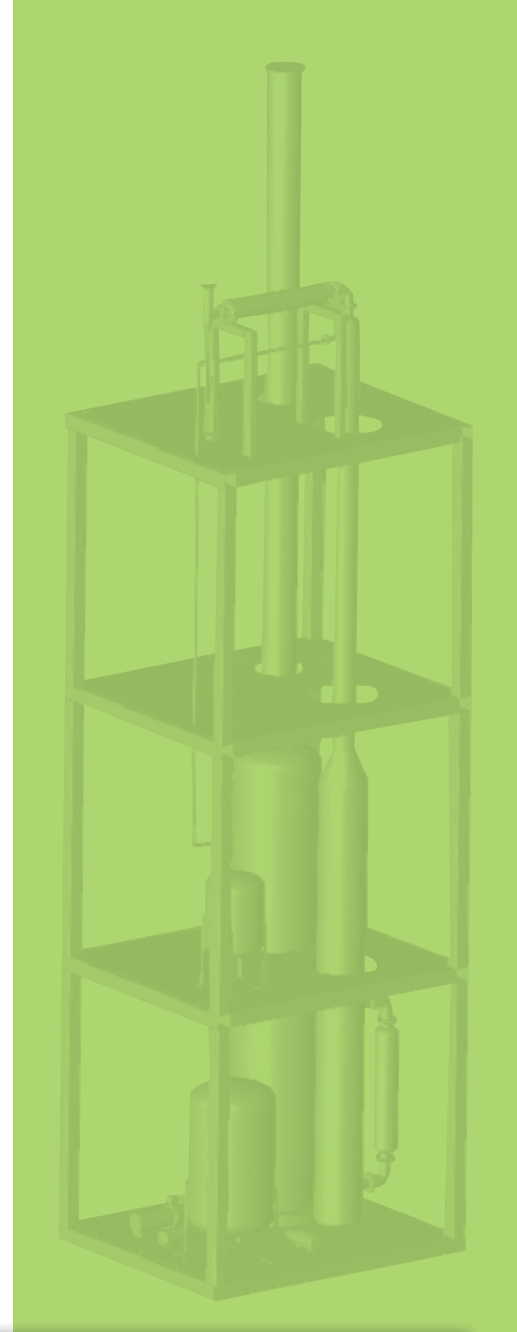


Typical solvents recovered:

- ✓ N-Ethylpyrrolidone (NEP)
- ✓ N-Methylpyrrolidone (NMP)
- ✓ Toluene
- ✓ Methylene chloride
- ✓ Trichloroethylene (TCE)
- ✓ Alcohols
- ✓ Ketones
- ✓ Nearly all types of hydrocarbons

Distillation & Purification

Following the recovery of NMP or NEP from the dryer exhaust stream, MEGTEC also provides equipment for the dehydration and purification of NMP or NEP to ultra pure/electronic grade specifications to allow reuse in the manufacturing process. All systems can be supplied pre-assembled on skids for ease of equipment installation.



Air Pollution Control by Oxidation

MEGTEC regenerative thermal oxidizers are available in sizes ranging from 4,000 scfm [6308 Nm³/hr] to 90,000 scfm [141930 Nm³/hr] capacity, in single and multiple can designs

For applications where solvent recovery is not appropriate, MEGTEC offers regenerative thermal oxidation (RTO) systems in different sizes and configurations for environmental compliance.

By applying our industry knowledge and expertise in process air handling, MEGTEC provides equipment that delivers regulatory compliance without affecting the performance of your process line or the integrity of your end product. With more than 4,000 equipment installations worldwide, we have both the industry experience and regulatory knowledge to design the right air pollution control solution for your process.



Worldwide Presence

Global Service, Parts Support & Regional Locations



Regional Locations

◆ Global Headquarters ◆ Regional Headquarters ● Regional Parts, Service

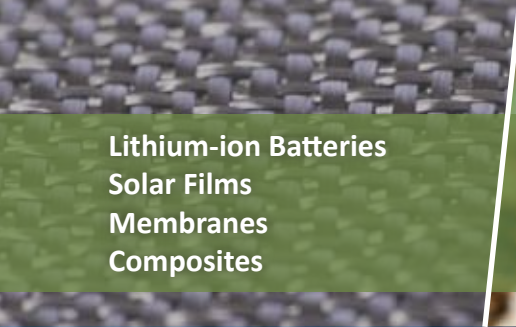
■ Manufacturing ■ Engineering ■ Service

AMERICAS	
◆ ■ ■ ■	De Pere, Wisconsin
■ ■	Vero Beach, Florida
■ ■	Columbus, Ohio

ASIA	
◆ ■ ■ ■	Shanghai, China
■	Singapore
■	Melbourne, Australia
■ ■ ■	Pune, India

EUROPE	
◆ ■ ■	Evry, France
■	Ingre, France
■ ■ ■	Maintal, Germany
■ ■ ■ ■	Åmål, Sweden
■ ■ ■	Göteborg, Sweden
■ ■	Maidenhead, UK
■ ■	Standish, UK

Advanced Materials Processing



Lithium-ion Batteries
Solar Films
Membranes
Composites

Environment, Climate & Energy



Air Abatement Systems
Carbon Management
Energy Recovery
Biofuels & Renewable Energy

Printing & Packaging Systems



Digital Printing
Commercial Printing
Newspaper Printing
Packaging

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