

# Machinery in Perfection

## Double-Sided Vertical Coating & Drying of LiPoBat Components

By Bob Sandbank

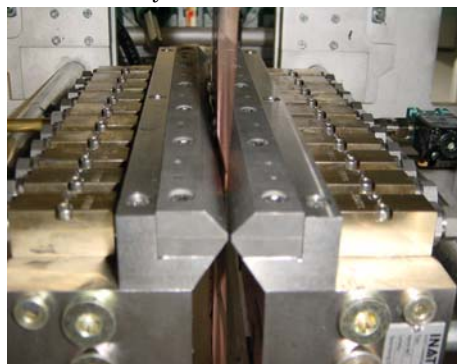
The battery manufacturing process is highly dependent on specialized coating, calendaring and laminating technologies. Advanced battery technologies like lithium-ion polymer and dry solid lithium-polymer require particularly efficient coating processes for the anode and cathode elements.

Battery developers can choose double or single-sided coating processes that are applied either horizontally or vertically. This article will present some of the advantages of a double-sided, vertically applied and dried process.

A double-sided coating process that uses a horizontal dryer requires the use of a tenter to suspend the coated material with optimum tension to prevent the coating from coming into contact with material handling devices such as rollers or guides until it is dried. The inclusion of a tenter in the process increases the costs of machinery and maintenance and the floor space required for a complete process.

The most efficient and cost effective process employs a double-sided, vertical coating and drying process that transports the coated material vertically until dry, eliminating the need for a tenter. As a bonus the vertical design of the machinery more efficiently uses the overhead space that is typically available in research and production facilities. This makes the footprint of the overall system smaller.

When considering a double-sided, vertical coating system for LiPoBat component production there are four primary areas of consideration.



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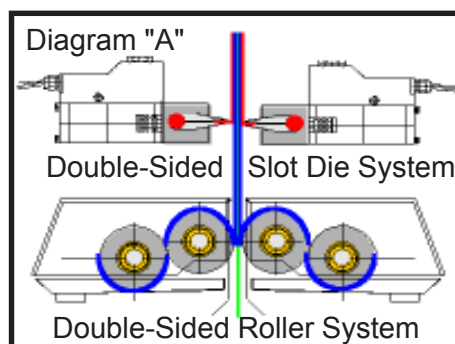


Diagram "A" depicts an in-line process that employs two methods of application in a two layer per side approach.



The Closed Roller process is another approach that has proven effective for LiPoBat component coatings.

These four steps are: the coating recipe; the substrate structure; the coating application method; and curing and drying.

### Recipe

The viscosity range, cohesive and adhesive forces in relation to the substrate, and the evaporation rate of coatings applied vertically are important considerations in the recipe formula.

### Substrate

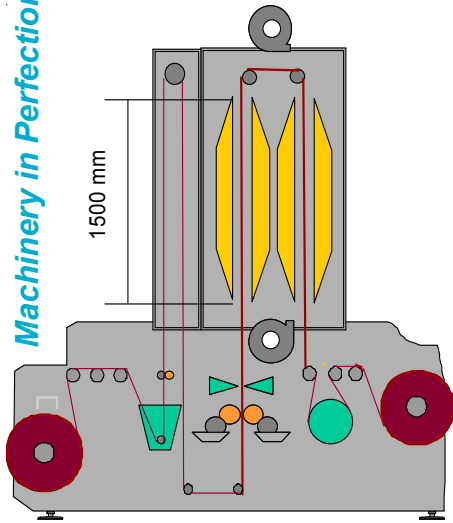
A perforated foil is best suited for vertical coating of battery components to help overcome the forces of gravity. The open structure of this foil allows for both the cohesion of the recipe from two sides and the adhesion to the surfaces.

### Application

The choice of an application head is determined mostly by the viscosity of the recipe and the structure of the substrate surface. The use of solvents in the recipe calls for a closed application system to offset high evaporation rates.

In this article we will focus on two coating application concepts. Although a wide range of dry spraying and other disposition methods are possible, we will concentrate on wet processes.

The *Slot Die* process, which is often used for application of hot adhesives, can be very effective in cold recipe LiPoBat component coating when a specialized pumping system is incorporated. Diagram "A" shows how the material is pumped into the slot die chamber and then applied to the substrate. The form and inner coating of the chamber are critical to performance.



Proprietary considerations preclude more detailed discussion in this article; but it can be said that the flow field in the slot die is influenced by the shear rate of the recipe due to pressure changes in the slot die chamber. Also, the design of the slot is critical for uniformity of coating disposition. The points of application of the coatings on both sides of the substrate can influence the migration and cohesion of the layers.

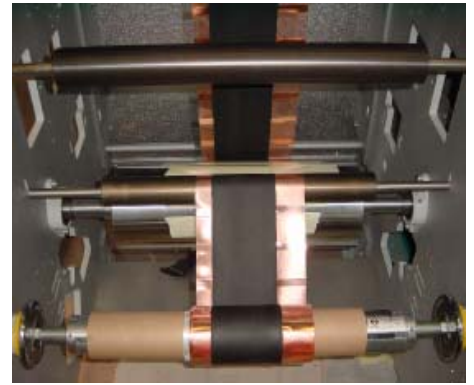
The *Closed Roller* process is another approach that has been proven effective in the vertical application of LiPoBat component coatings. This method is especially effective when the dipping roller is engraved to control the coating weight. The advantage of this process over the slot die approach is the tolerance of roller application to viscosity variations. Also, roller systems are easier to clean so they reduce downtime in an environment where coating recipes are changed frequently or process shut downs require purging.

Diagram “A” depicts an in-line process that employs both methods of application in a two layer per side approach. Of course the ability to use one or the other method independently is inherent in such a system.

### Curing and Drying

Vertical double-sided coating followed by vertical curing and drying requires a double-sided hot air jet system where temperatures of up to 235 ° C can be achieved and maintained. This allows the material to be sufficiently cured and dried before coming in contact with a roller or guide system.

It is important that the curing and drying system be designed to contend



The Verticoater 500-1000, from Coatema Maschinenbau GmbH, is a double-sided vertical coating, drying and calendering systems currently in use for LiPoBat components.

with the thermal issues that can occur due to the chimney effect of a vertical process. This is especially important when high concentrations of solvents are present in the recipe. The accumulation of condensation in the top of the system must also be a design consideration. Overall, the design of the curing and drying system requires a high level of process knowledge and engineering competence.

Curing and drying can be followed by other vertical processes, like calendering to compress the material to achieve higher electrical densities in the finished LiPoBat product, but that is a topic for a future article.

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Editor's Note: Bob Sandbank is the President of EurotecUSA and represents Coatema Coating Machinery GmbH in the United States, Canada and South America.

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Represented by:



**Coatema**

**Coating Machine Builders**

**EURO TEC USA Inc.**

2378 E. Big View Dr., Oro Valley, AZ 85755

520.818.9551 INFO@EUROTECUSA.COM