Coating and Materials Handling Technologies for Prepregs

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Today the use of coated products for prepregs is growing rapidly. This increasing demand has resulted in the development of new and highly innovative impregnation and coating machinery concepts for prepregs at Coatema Coating Machinery GmbH.

The world wide trend in prepreg machinery is favouring flexible, multifunctional systems for the production of various products made from rovings, textiles and multiaxial structures. The combination of fibres like carbon, glass and Kevlar® with epoxies for the use in reinforced plastics for light-weight products in the aerospace, sports and automotive industries is gaining more and more importance.

The design of specialized coating technologies and the effective treatment of the fibre materials for prepreg products present a number of mechanical engineering challenges. Generally prepregs are temperature activated intermediate products with tailor made properties. Application advantages for the use of prepregs are:

- superior stiffness
- high tensile strength
- low density
- corrosion resistance
- high vibration resistance
- low heat elongation
- low weight
- extraordinary fatigue resistance
- easy installation in use
- low maintenance costs in use

For the machinery solution in general it is necessary to apply epoxy resin or phenol resin chemistry on a variety of substrates made of different material types.

Difficulties in handling various products must be evaluated for winding, material guiding, coating and drying processes. Depending on the substrate, the coating chemistry and the end product it is necessary to perform detailed equipment evaluation.
Material Types and Product Design

Coatema has considerable experience handling prepreg fiber materials, which are mainly:

- carbon fibers
- glass fibers
- Kevlar® fibers
- graphite fibers
- other man-made fibers

There are also differences in the layouts of fibre products including:

- woven fabric
- uni-, bi- and multi-directional fibers constructions
- products that have more than one orientation depending on the desired strength direction

Depending on the material structure it is necessary to define the handling technology in winding off via creels or roll winders.

Depending on the number of rovings to be coated, creels of different sizes are used to wind off the rovings in parallel and feed them to the coating process. The control of tensile strength is essential, as both too tense rovings as well as sagging ones cause problems. Both could result in an uneven coat and thus become unusable product due to poor quality.

Mainly low slippage resistance creates problems in handling of woven or multiaxial substrates. Very precise tension adjustments must be assured. Each disarranged fibre influences the resulting force distribution in the structural component part.
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**Chemical Solution and Coating Technologies**

An additional requirement for special handling of products for prepreg materials is influenced by the use of chemical solutions. Resins (matrix) as coating materials can include:

- solvent or water based epoxy resins
- powder like materials
- hotmelt resin
- phenol systems
- polyester/vinyl ester/acrylic resin systems

The substrate must be brought into the optimal position using guiding systems before coating. The substrates must be fed to the coating system and subsequent drying process without displacing fibres in the rovings or woven fabrics. The slippage resistance of woven substrates are very low and very often cause problems. There is nearly no physical adhesion between the fibre bundles so the substrate has to be guided very carefully into the coating process by guiding rollers with very smooth surfaces.

There are a variety technologies available for filament coatings, with dipping technology and heated knife coating generally being the preferred. Filament coating possibilities include:

- dipping systems
- knife coating technologies (often heated)
- roller systems
- slot die technologies
- powder scattering
- hotmelt-technologies

Some of these coating systems are shown in the following pictures and drawings. The choice of the right coating system must be determined in consideration of the chemistry, the application weight and the viscosity of the coating material among other factors.

Furthermore the differentiation in complete impregnation or only single side coating influences the choice of the coating system.
Problems of handling of the products are often due to:

- breakable fibres
- the need for complete coverage of the fibres if coating single rovings or closed substrates
- critical damp during the drying process like formaldehyde and phenol compounds

**Drying Technology**

The coating technology is necessarily followed by drying, a very important feature of a prepreg coating line. In general precise adjustments of the drying or curing processes must be realized for a high quality end product. Available techniques are:

- drying via hot air
- drying via IR

Depending on the coating material and the thickness of the layer, both drying methods can be used.

Convective dryers are used with solvent-based raw materials and when very consistent air control is necessary. IR-technology accelerates the drying process as the radiation warms the substrate from inside and the heat is quickly adsorbed by the substrate. This is the ideal drying method for high production speeds and for water-based coating materials. Because the heat migrates from inside the substrate to the outside, the product can dry much faster.

**Plant Concepts and Summary**

Important parameters for coating plants for prepreg handling result in specialized plant layout such as:

- various winding technology with perfect tension control
- various coating technologies depending on the coating weight and the coating chemistry viscosity and delivery
- drying technology depending on the coating chemistry (water or solvent based)
- appropriate exhaust technology
End users choose composite materials due to the characteristics of weight, strength and economy of use. As a result of the extreme differences in individual products, expectations from production machines are very high.

With decades of experience the Eurotech-Coatema team is in a position to offer highly innovative and economical prepreg machine concepts tailored to each customer’s specific needs.