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Open mold fabrication of Polymer Matrix Composites

Dr. Dmitri Kopeliovich

Open Molding (Contact Molding) is the simplest method of fabrication of Polymer Matrix Composites.

Open Molding is usually used for manufacturing large individual parts (swimming pools, boat bodies).

Open Molding method is mostly used for fabrication Glass fiber reinforcing Polymers (**Fiberglasses**) with polyester (sometimes **epoxy** or vinyl ester) matrix.

The methods of open mold fabrication:

- **Hand Lay-up**
- **Spray-up method**
- **Tape Lay-up**
- **Filament Winding**
- **Autoclave Curing**

Hand Lay-up

The most popular type of Open Molding is Hand Lay-up process. The Hand Lay-up is a manual, slow, labor consuming method, which involves the following operations:

- The mold is coated by a release anti-adhesive agent, preventing sticking the molded part to the mold surface.
- The prime surface layer of the part is formed by applying gel coating.
- A layer of fine fiber reinforcing tissue is applied.
- Layers of the liquid matrix resin and reinforcing fibers in form of woven fabric, rovings or chopped strands are applied. The resin mixture may be applied by either brush or roll.
- The part is cured (usually at room temperature).
- The part is removed from the mold surface.

The disadvantages of the Hand Lay-up method are: low concentration of **reinforcing phase** (up to



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30%) and low densification of the composites (entrapped air bubbles).

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Spray-up

In Spray-up process liquid resin matrix and chopped reinforcing fibers are sprayed by two separate sprays onto the mold surface.

The fibers are chopped into fibers of 1-2" (25-50 mm) length and then sprayed by an air jet simultaneously with a resin spray at a predetermined ratio between the reinforcing and **matrix phase**.

The Spray-up method permits rapid formation of uniform composite coating, however the mechanical properties of the material are moderate since the method is unable to use **continuous reinforcing fibers**.

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Tape Lay-up

In this method layers of prepreg (reinforcing phase impregnated by liquid resin) tape are applied on the mold surface by a tape application robot.

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Filament Winding

Filament Winding method involves a continuous filament of reinforcing material wound onto a rotating mandrel in layers at different layers. If a liquid **thermosetting resin** is applied on the filament prior to winding the, process is called Wet Filament Winding. If the resin is sprayed onto the mandrel with wound filament, the process is called Dry Filament Winding.

Besides conventional **curing** of molded parts at room temperature, Autoclave Curing may be used.

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Autoclave Curing

Autoclave Curing is a method in which a part, molded by one of the open molding methods, is cured by a subsequent application of vacuum, heat and inert gas pressure.

The molded part is first placed into a plastic bag, from which air is exhausted by a vacuum pump. This operation removes air inclusions and volatile products from the molded part.

Then heat and inert gas pressure are applied in the autoclave causing curing and densification of the material.

Autoclave Curing enables fabrication of consistent homogeneous materials. The method is relatively expensive and is used for manufacturing high quality aerospace products.

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