ELSEVIER

A revolutionary auxiliary film development for composite manufacturing

FEATURE

Soheila Salehi-Schneider and Felix Grimm

As application opportunities for composite materials grow, manufacturers have become acutely attuned to the need for process improvements that generate real cost savings, accelerate production and improve part quality. This is particularly true for the large-scale fiber-reinforced plastic (FRP) components currently employed in industries such as aerospace, automotive, marine, and wind energy. Soheila Salehi-Schneider, Project Leader at Infiana, explains how the award-winning Flex$^{PLAS®}$ release film technology creates opportunities to streamline these complex processes.

Since 2015, the manufacturing experts at Infiana, one of the world's leading producers of engineered films, have been working together with scientists at the Fraunhofer Institute for Manufacturing Technology and Advanced Materials (Fraunhofer IFAM) in Bremen and Stade, Germany, on the development and marketing of an innovative release film technology designed from the ground up to address the need for improvements in composites manufacturing techniques. Combining Fraunhofer IFAM's renowned expertise in plasmapolymeric coatings with engineered films custom-developed and produced by Infiana in Forchheim, Germany, Flex$^{PLAS®}$ enables the release agent-free production of FRP parts with an excellent, ready-to-paint or ready-to-bond surface finish without residue contamination.

Reduced costs, improved productivity

One key area where Flex$^{PLAS®}$ creates significant efficiencies is in the demolding and surface finishing process. In typical FRP manufacture, release agents are applied to the surface of a mold to ensure easy removal of the components after curing. However, these agents also leave behind traces of fluorine, wax or silicone. Such residues have to be removed from both the manufactured part and the mold through abrading and blasting, i.e. surface activation, before any further processing can take place. This is a complex, time-consuming process – one that not only strains the surfaces of part and mold, but adds manufacturing cost.

These steps are no longer required with Flex$^{PLAS®}$ release film, which is applied directly into the mold in place of the typical release agents, then deep-drawn to act like a second skin. Leveraging engineered film solutions produced by Infiana, Flex$^{PLAS®}$ demonstrates a high elasticity of up to 300 percent and is thermally stable at temperatures of up to 190°C. With this combination of properties, Flex$^{PLAS®}$ can be readily used in many equipment types and techniques, such as prepreg/autoclave, vacuum infusion or press processes.

The Flex$^{PLAS®}$ release film and the fibrous material are cured together in the mold; once the curing process is complete, the film is simply peeled off, leaving behind a finished part that is immediately ready to paint or bond. Smooth removal is ensured through a thin plasmapolymeric coating which is adjustable according to customer requirements. Alternately, the film can be left on the cured component, providing a protective layer until the next process step or during transportation. Process steps such as trimming, drilling, non-destructive testing (NDT) or water jet cutting can all be carried out while the film is still attached to the part (Fig. 1).

Additional efficiencies can be created through in-mold gel coating. Gel coats are generally used in composites manufacturing for reasons of esthetics or durability, and are applied to molds in the form of a modified liquid resin. The marine, aerospace, and wind sectors in particular make use of gel coatings on exposed surfaces to provide high quality finishes, as well as added protection against factors such as ultraviolet degradation. In mass production, gel coats are applied by hand-painting or spraying; if multiple passes are required, each application of gel coat must be allowed to cure before the next layer is applied.

0034-3617/ http://dx.doi.org/10.1016/j.repl.2017.05.001

Please cite this article in press as: S. Salehi-Schneider, F. Grimm, Reinf. Plast. (2017), http://dx.doi.org/10.1016/j.repl.2017.05.001

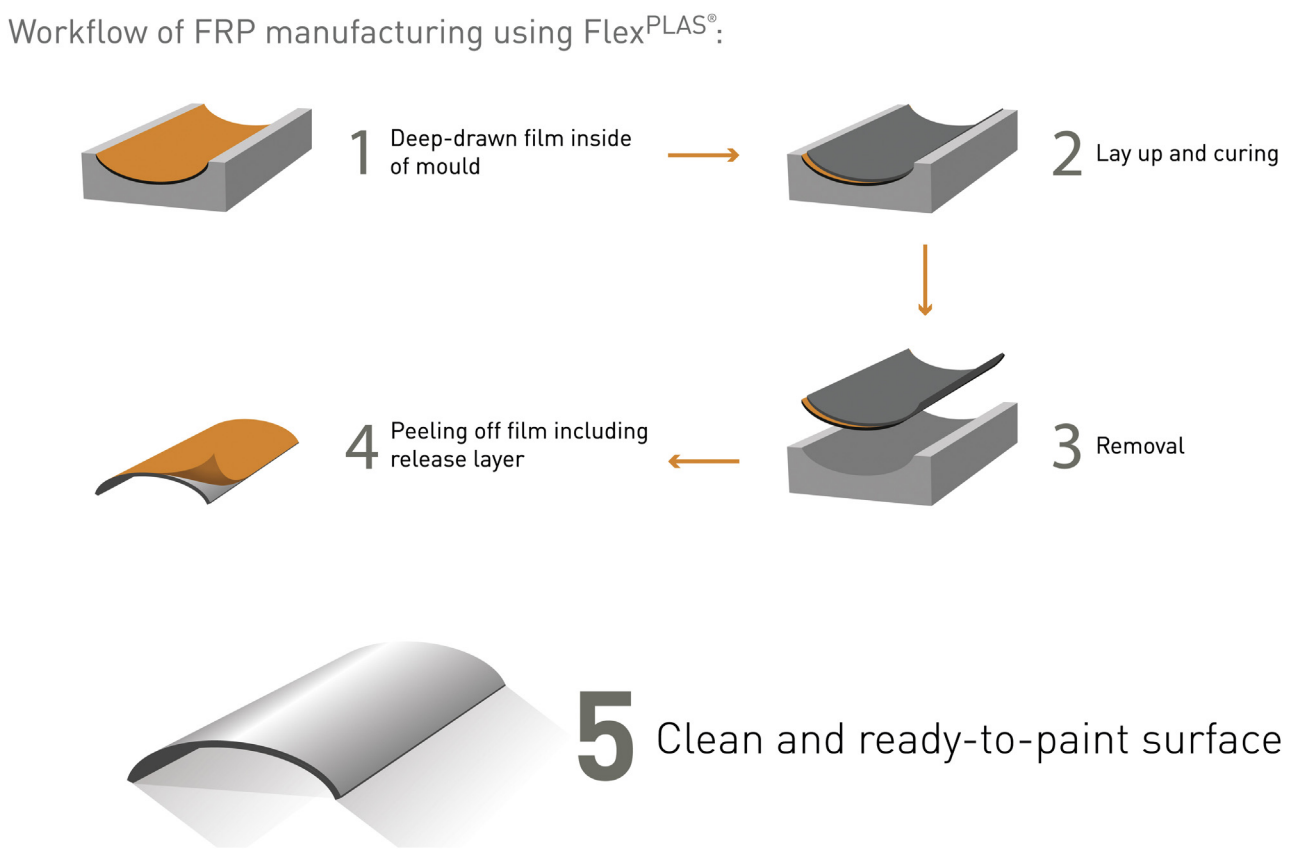

FIGURE 1

Flex[PLAS®] is deep-drawn into the mold like a second skin in place of the release agents typically used in composite manufacturing. Highly elastic and thermally stable at up to 190°C, Flex[PLAS®] can be used in many equipment types and processes.

Flex[PLAS®] simplifies this process significantly. By applying a gel coat directly to the Flex[PLAS®] release film before it is covered with fibrous material, the coating can be cured together with the component in a single production stage, resulting in a pre-coated or pre-painted part immediately after demolding is complete. In doing so, the overall risk of coating defects is also minimized.

Additionally, the amount of gel coat, i.e. layers required, can be drastically reduced. At current, many applications require process coats with a high coating weight – up to several 100 μ/m^2 – as an initial layer on the FRP part before the topcoat can be applied. With conventional technologies, the process coat layers must also have a certain minimum thickness in order to provide a sufficient high surface quality free of pores. Furthermore, a large portion of this in-mold process coat must be subsequently removed again through processes like sanding before the final topcoat is applied. This ensures that lacquer adhesion is not impeded by any remaining release agent residues.

With Flex[PLAS®], only a fraction of typical in-mold process coat is required, as the Flex[PLAS®] film already provides a residue-free and uniform surface finish for the part. In some cases, the process coat can even be eliminated entirely; here, the final topcoat can be applied directly to the surface of the FRP component, which is protected by the Flex[PLAS®] film.

In giving manufacturers the ability to strategically remove or combine otherwise labor-intensive process steps, Flex[PLAS®] solutions offer the potential to reduce relevant production costs by up to 60 percent. Furthermore, eliminating the use of solvents during the curing and demolding process has positive environment effects; the Flex[PLAS®] film itself is recyclable. Solvent-free manufacturing and in-mold gel coating also increase workplace safety and protect employees' overall well-being by minimizing exposure to dust and volatile organic compounds (VOCs).

New applications through product innovation

Using films as a carrier for the plasmapolymeric coating not only has the benefit of increasing the scale at which Flex[PLAS®] can be applied. By modifying the film itself, a range of additional functionalities can be unlocked, along with corresponding production efficiencies.

Film innovation is well-established practice at Infiana, which bills itself as 'the Premium Innovator'. By taking advantage of the company's established in-house conversion steps, like coating, embossing, printing, and lamination capabilities, Infiana has the ability to produce everything from permanent antistatic films to counterfeit-proof packaging under one roof. New product concepts can be evaluated at the company's in-house laboratory and pilot plants, which allow for a rapid assessment of process and product development for novel film solutions that will ultimately meet highly specialized client- and market-specific demands.

Such concepts can be generated through in-depth customer discussions carried out via the Infiana 'Collaborate + Innovate' process, through strategic market and trend analysis, or through Infiana's internal idea-sharing initiative, which collects suggestions for new products and product improvement from the com-

Please cite this article in press as: S. Salehi-Schneider, F. Grimm, Reinf. Plast. (2017), http://dx.doi.org/10.1016/j.repl.2017.05.001