PIONEERING DEVELOPMENT: FLEX$^{PLAS®}$ ALLOWS LARGE FRP COMPONENTS TO BE MANUFACTURED WITHOUT THE USE OF RELEASE AGENTS

Flex$^{PLAS®}$ is the name of a new release film which obviates the need to use conventional release agents when manufacturing large components made of fiber reinforced plastics (FRPs). The film, which was developed by Fraunhofer IFAM experts of Plasma Technology and Surfaces PLATO, Bremen, and Fraunhofer Project Group Joining and Assembly FFM, Stade, has a number of key advantages. Indeed, it is attracting attention in many sectors of industry, because it has considerable time and cost saving implications for product manufacture.

It concerns a process that is repeated thousands of times a day on a small scale: A component is manufactured using a mold and thereafter the mold is removed. To prevent sticking to the mold, a release agent is sprayed onto the surface of the mold. This then enables the component to be easily demolded after the curing step – just like removing a cake from a greased tin after being baked in the kitchen oven. Scientists from the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM have developed a pioneering technology which also allows large FRP components to be manufactured faster and at more favorable cost. Many sectors of industry are using ever more carbon fiber reinforced plastic (CFRP) materials and this new release film technology paves the way for efficient series production of these components. The Flex$^{PLAS®}$ film is an extremely elastic polymer film that is coated with a flexible plasma-polymer release layer. It allows easy removal of components from molds, even when stretched by 300 percent.

Large FRP components are being increasingly used for, amongst other things, manufacturing aircraft or wind turbines. Materials such as CFRPs are of great interest for these industries: They are light, can bear extremely high loads, and can be readily customized to meet specific requirements. The molding process hitherto was very complex, because conventional release agents left residues on both the component and mold. Cleaning and, in some cases, sanding down of the surfaces of components were arduous and crucial processes, not only with a risk of damaging the component but also requiring costly downtime during the manufacturing process.

The concept of the deep-drawable Flex$^{PLAS®}$ release film had its origins during Fraunhofer IFAM work developing molds coated with a non-stick coating applied using a low pressure plasma process. Here, the molds were treated in a reactor at low pressure by introducing special gases into a plasma. Highly reactive fragments of silicon or carbon molecules in the plasma lead to layers that have excellent adhesion to the mold. A mold modified in this way can be used up to 1000 times before a new coating has to be applied. This was a quantum leap compared to the then current method using sprayed on release agents. The release technology has been developed over a number of years by PLATO.

Film coating in a plasma reactor

As plasma reactors are limited in size and so are unsuitable for manufacturing large components, the technology had to be further developed. The solution: Not the mold is coated in the plasma reactor, but rather an elastic, tear-resistant, plastic film. The plastic film is less than 0.1 millimeters thick and the plasma-polymer coating, which leaves no residues at all on the component surface, is only 0.3 microns thick. The film rolls pass into the reactor on a carriage (Fig. 1) – the film is unwound and then wound up again in the plasma. The PLATO experts optimized the plasma process: The molecule segments within the layer align themselves so that there are no longer any chemically reactive groups on the surface – so the coating allows perfect separation of the component from the mold.

Due to the fact that the film can be stretched by up to 300 percent, it can be readily applied to curved or structured molds without folds forming. It is hence ideal for the series production of very large FRP components (Fig. 2). A goal of Fraunhofer FFM at the Forschungszentrum CFK NORD (Research Center CFRP North) in Stade is to further develop this technology for industries such as the aircraft manufacturing industry or wind energy sector. Working together with PLATO, the Flex$^{PLAS®}$ release film technology has been optimized for industrial applications: Large full-sized CFRP components have successfully been manufactured using the prepreg method at 180 degrees Celsius in an autoclave.

Immediate coating possible

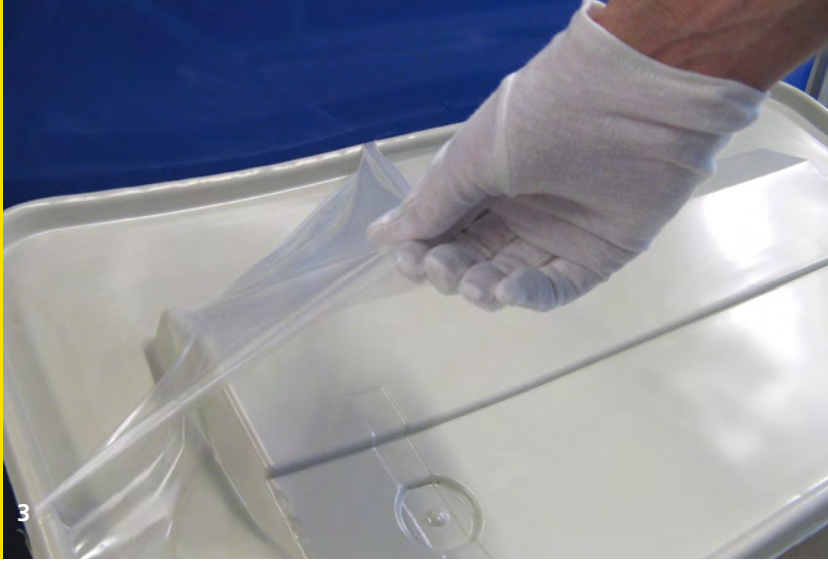
Tray-shaped molds made of special steel are used for this method. The Flex$^{PLAS®}$ release film is first placed in the mold. Vacuum pumps then extract the air between the mold and film – leaving no folds. The CFRP sheets can then be placed in the mold in the desired thickness; after "baking" in the autoclave and cooling, the component can be demolded without any release agent residues. The release film can be easily removed but if desired can also remain on the component to provide protection during transport.

As the component surface is free of contamination and release agent residues after removing the film, it can be coated immediately without further pre-treatment. The new method also allows in-mold coating of FRP components. For this a gelcoat is applied with comparatively low effort to the Flex$^{PLAS®}$ film in the mold. The production of the FRP component then takes place on the coating. The in-mold coating and the FRP component are cured together and the coated component with the release film is then removed from the mold (Fig. 3).

These developments have created huge interest and there have been numerous enquiries from industry.

1 *The low pressure plasma reactor is used to coat and functionalize the film for the Flex$^{PLAS®}$ release film.*

2 *Checking the deep-drawn, fold-free Flex$^{PLAS®}$ release film in the mold for a CFRP fuselage shell.*



3

The Industrievereinigung Verstärkte Kunststoffe e. V. (AVK; Federation of Reinforced Plastics) awarded Dr. Matthias Ott – PLATO – and Dr.-Ing. Gregor Graßl – Fraunhofer FFM – the AVK Innovation Prize 2012 for their scientific work on Flex$^{PLAS®}$ release film. The award was presented at the Composites Europe 2012 fair. The Fraunhofer IFAM scientists won the first prize in the category "Innovative processes and methods" (see Page 124: "AVK Innovation Prize 2012 for Flex$^{PLAS®}$ release film awarded to Dr.-Ing. Gregor Graßl and Dr. Matthias Ott").

Outlook

A key objective of the development work is to utilize the advantages of release agent free FRP component manufacture for a wide array of applications in the future. Besides processes involving preimpregnated fibers, the focus will also be put on infusion methods where liquid resin flows around dry fibers in closed molds. A further challenge is the manufacture of glossy CFRP surfaces that require no complex grinding and polishing processes.

CONTACT

Dr.-Ing. Gregor Graßl
Fraunhofer Project Group Joining and Assembly FFM
Phone +49 4141 78707-222
gregor.grassl@ifam.fraunhofer.de

Dr. Matthias Ott
Plasma Technology and Surfaces PLATO
Phone +49 421 2246-495
matthias.ott@ifam.fraunhofer.de

Institute

Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM,
Adhesive Bonding Technology and Surfaces, Bremen and Stade

3 *Removing the Flex$^{PLAS®}$ release film, developed at Fraunhofer IFAM, from a FRP component which was coated with a gel-coat in the mold.*