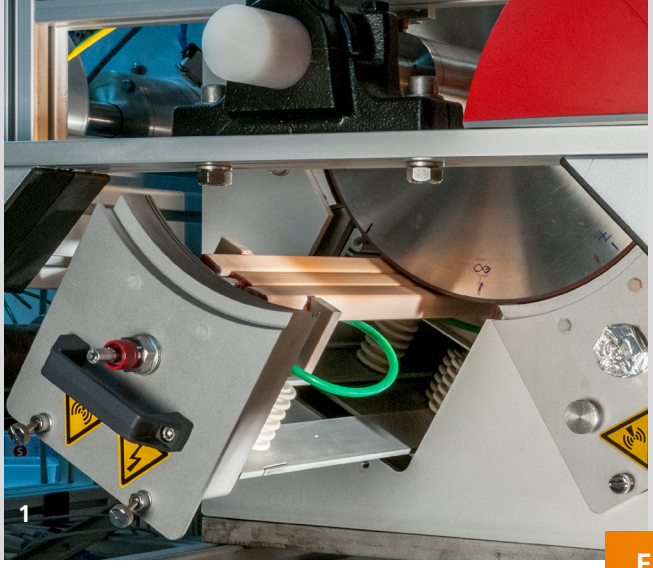

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Extract from the annual report 2018
To the website: www.ist.fraunhofer.de/en.html

PLASMA REPLACES ADHESIVE – NOW ALSO AS ROLL-TO-ROLL

The utilization of new materials is an essential foundation for the innovations of the 21st century and the basis for modern products in all areas of life. The demand for composite films, e. g. for food packaging, flexible circuit board or decorative and protective films, is increasing continuously. Therefore, the Fraunhofer IST is working together with project partners on a solution for the scaling-up of a new inline-capable joining process for the production of such composite materials from metal and plastic films.

Scaling-up to the roll-to-roll procedure

Within two successfully completed IGF projects of the German Federation of Industrial Research Associations (AiF) in collaboration with the Forschungsinstitut Leder und Kunststoffbahnen (Research Institute of Leather and Plastic Sheeting, FILK) in Freiberg, a process for the lamination of plastic/plastic and metal/plastic composites through surface functionalization by means of atmospheric pressure plasmas has been developed. The functionalization is based on an oxygen-free plasma treatment using precursors.

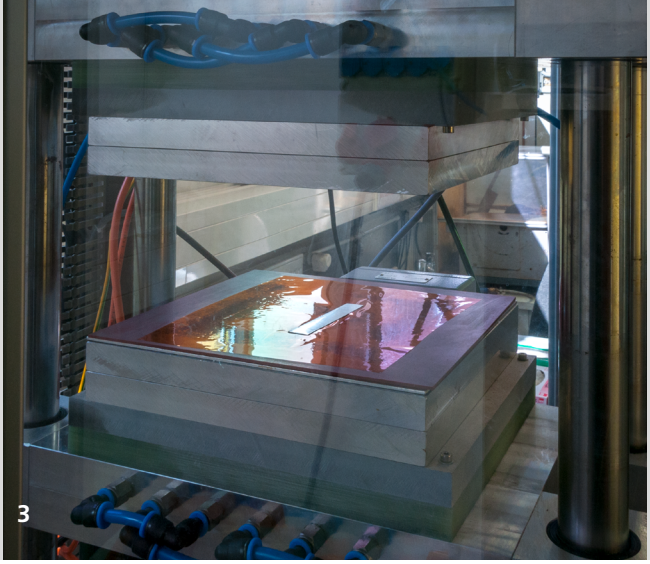
Directly after the joining surfaces have been equipped with chemically reactive groups, the lamination takes place considerably below the melting temperature, e. g. at 60 °C. The process is currently being scaled-up as an inline process, thereby further reducing the time between functionalization and lamination. This enables the integration of this procedure into existing inline processes. The substrate speed can be adjusted through the design of the plasma path and the roll or belt laminator. In order to adjust the plasma functionalization to the lamination in continuous operation, the surface functionalization is optimized. This applies to both the density of the reactive groups across the treatment width and the uniformity over a continuous coating time of eight hours.

State of the art

The aforementioned composites still have to be partially activated wet-chemically and joined using diverse adhesives today. These are usually solvent and water-based adhesives, UV adhesives or adhesive films. Ultimately, the adhesive strength between the material components should be at least high enough for adhesion breaks to stop. Simultaneously, the requirements placed upon composites are increasing in terms of material usage, long-term durability and creep tendency or migration. These requirements are often economically unattainable with adhesive joints. The thermal adhesive-free lamination can, however, only be applied between compatible material pairings. The material properties, such as optical quality or haptics, often suffer as a result of the melting of a joining partner.

Outlook

Restrictions which have, until now, stood in the way of an industrial application of the plasma process for joining are the challenges with regard to the quality assurance of the surface functionalization as well as electrode contamination during longer process times. In order to establish an understanding of the correlation between layer thickness and adhesive force, investigations are carried out by means of ellipsometry. This



1 *Aldyne™ plant for continuous roll-to-roll coating.*

2 *90° pull-of tester for foil composites.*

3 *Thermo-compression bonder for plasma pretreated film components.*

makes it possible to precisely determine even nanometer-thick layers on foils. Furthermore, infrared spectroscopy can be implemented in order to acquire knowledge concerning physical and chemical processes and the associated surface changes. The characterization of the precursor concentration in the process gas is performed by means of mass spectrometry. One objective of the investigations is the scaling-up of low-temperature joining for industrial applications, thereby providing small and medium-sized enterprises with better access to this technology.

The project

Project 19571 N of the research association "Verein zur Förderung des Institutes Leder und Kunststoffbahnen Freiberg/Sachsen e.V. FILK" was funded by the German Federal Ministry for Economic Affairs and Energy via the AiF within the framework of the program for the promotion of joint industrial research (IGF) on the basis of a resolution of the German Bundestag.

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