



**Fraunhofer**  
IGB

Fraunhofer Institute for Interfacial  
Engineering and Biotechnology IGB

Continuous finishing of web material

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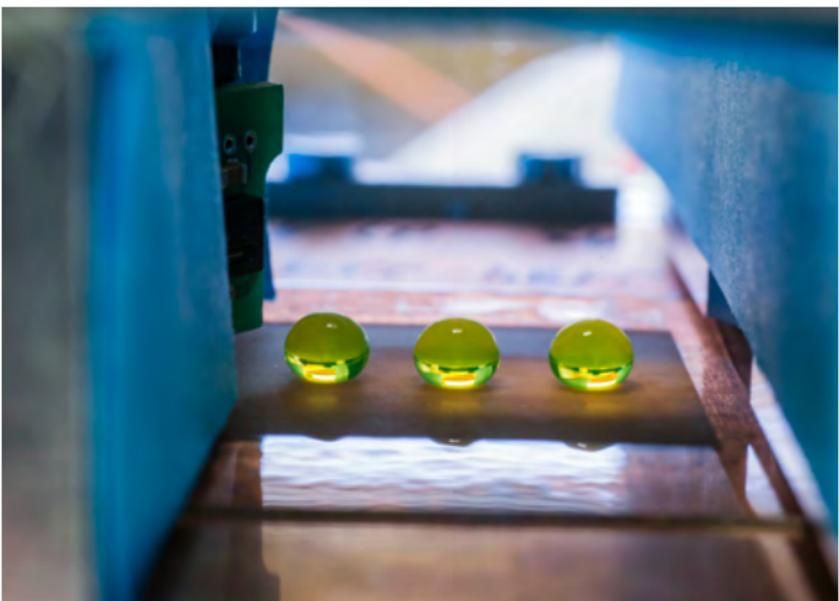
Roll-to-roll coating  
and structuring

Functional surfaces provide new properties to products and materials and thus open up new areas of application. At Fraunhofer IGB, we develop functional coatings with water-, oil- and dirt-repellent properties. Barrier coatings against oxygen, water vapor and various chemicals can also be produced.

## Multiple roll-to-roll process combinations

With our technical equipment, we are able to finish web materials such as films, nonwovens or textiles using wet-chemical and gas-phase processes in roll-to-roll (R2R) processes, and to combine different coating procedures. In addition, we offer processes for surface structuring, which can also be carried out in R2R. For example, films are first structured in the roll-to-roll process via hot embossing processes and then provided with ultra-thin plasma coatings to obtain superhydrophobic and ice-repellent surfaces through this combination.

We develop the desired equipment and transfer the processes to an R2R process on our plants. We would be happy to discuss your project in an initial meeting, please contact us.



*Ice test stand*

# Applications

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## Anti-icing films

Water and ice repellent PU foils prevent icing of surfaces. The base material is self-adhesive, transparent and erosion-resistant, making it suitable for application to wind turbines, wings, skis, sensors and many other surfaces.



## Barrier layers

The finishing of foils with barrier layers is particularly in demand for packaging. The layers are often based on glass-like compounds, which can be deposited in low-pressure plasmas R2R.



## Protective coatings

Protective coatings can be designed according to the application requirements. These include anti-corrosion coatings, anti-scratch and anti-slip coatings, and many more.

# Process development: from batch to R2R processes

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Compared to the finishing of films in small format, various conditions have to be taken into account for continuous treatment. The transfer from batch to R2R processes and possible process combinations can be illustrated using the example of water- and ice-repellent finished PU foils.

## Foil structuring by means of hot embossing

At Fraunhofer IGB, we primarily use hot embossing for surface structuring, both in small format and R2R. The optimum process parameters (temperature, heating and cooling profile, embossing pressure) depend on the polymer properties and are adapted in each case. Depending on the temperature and holding time at high pressure, we achieve structure heights of between 10  $\mu\text{m}$  and 40  $\mu\text{m}$  in the foil in the R2R process.

When hot embossing small-format foils, we work with a hot press that transfers the desired structure to the foil via an embossing stamp. With the hot press, different temperature levels can be used to achieve an optimum result. Transferring this process one-to-one to R2R would, if at all, only be feasible with immense technical effort and would hardly cover costs.

The small-format hot stamping die is the equivalent of a calender in R2R processes. The roller temperature, pressing and throughput speed can be set accordingly for optimum process control. Infrared or hot air are used for fast temperature control outside the calender. The parameter window in which R2R can work with foils depends on the material and, e.g. in the case of composite films with adhesive coating, on

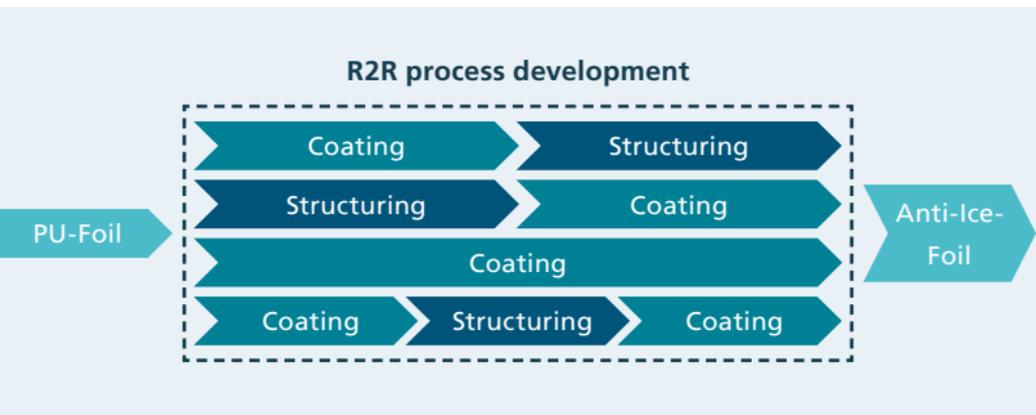
the foil structure. We already take these considerations into account in the early-stage development on a laboratory scale.

In the example of water- and ice-repellent films, we were able to increase the static water contact angle of the polyurethane foil used from approx. 75° to up to 135° in this way, without applying an additional water-repellent coating.

## Plasma coating

When plasma processes are transferred to R2R, possible out-gassing of the web material must be taken into account. This mainly concerns the gas flow in the chemically highly reactive plasma zone. The electrical power input, the travel speed of the foil and other process parameters are adjusted so that the coating can be applied with the best possible layer quality at the highest possible throughput.

Such a plasma coating on the pre-structured polyurethane foil made it possible to further increase the water contact angle to a total of around 160° and thus to obtain a superhydrophobic surface that qualitatively matches the laboratory-scale results.



*In R2R process development, coating and structuring processes can be combined in any order.*

# Equipment

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We use the following plants for process development and screenings within the scope of research projects and on behalf of customers:

## **Customized plasma chamber PINK V340-GKM**

- For foils, woven and non-woven materials up to a width of 400 mm
- Winding setup with both coils inside the vacuum chamber
- Two different plasma sources
  - cooled high frequency electrode system
  - microwave driven duo plasmaline system (Muegge GmbH)

## **Low pressure fiber treatment system**

- Self-built low-pressure fiber treatment system for R2R processes
- Air-to-air treatment via several pressure stages
- Fiber transport by conventional winders allowing different winding speeds etc.

## Continuous structuring (SC24 Coatema)

- Multifunctional plant consisting of several elements
- Structuring in micrometer range by means of calender unit
- Transfer of the negative structure of the upper roll onto foil with adjustable counterpressure of the lower calender roll
- Rollers can be heated individually for increased structure imaging
- Foil speed up to 10 m/min
- Width of the structured calender roll: 400 mm



*Coatema plant*

## Combined facility for plasma and wet chemistry

- Plasma chamber with a volume of approx. 1 m<sup>3</sup>
- Operation at different pressures
- Operation in combination with wet chemistry

This reactor is suitable for screening purposes, e.g. for plasma activation and subsequent spray deposition of reactive chemicals. It provides a closed environment not only for use as a low-pressure system, but also to control the gas atmosphere (e.g. inertness) at elevated pressures and, if necessary, for keeping potentially hazardous wet chemicals in a closed compartment.

## R2R process development

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- Material-independent (textiles, plastic films, etc.)
- Individual on customer request
  - With or without structuring
  - With or without coating
  - Combination of structure and coating
- Accompanying analysis (e.g. static and dynamic contact angle, determination of surface energy, chemical surface composition)
- Internal resistance tests (e.g. sand erosion)
- Scale-up from batch to R2R process

## Contact

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