Microcoating System

In view of the development of resource-efficient manufacturing technologies or the personalization of mass-produced goods, selective coating technologies for industrial use are becoming ever-more important.

These technologies are capable of applying precisely-delineated, mask-free and multi-color coatings and avoid overspray.

Coatings are applied to selective areas with sharply-defined edges without the need for masking. They can be used for decorative purposes, or to create local functionalized surfaces, for example with conductive properties, or to apply special thin-film systems based on nanomaterials, which are difficult to process using conventional techniques such as spray painting. The long-term goal is to completely eliminate overspray and thus drastically improve plant technology and energy requirements for coating applications.

With the microcoating system, Fraunhofer IPA aims to make alternative coating methods accessible to users from various industries and to develop new technologies.

The heart of the demonstration system at IPA is a 6-axis robot with high repeatability, which is capable of performing the precise movements required for selective coating.

Various adaptable application modules can be used. An external computer takes over the higher-level control of the robot and the modules. Analog and digital inputs and outputs allow universal use, even for new application modules and peripheral devices.

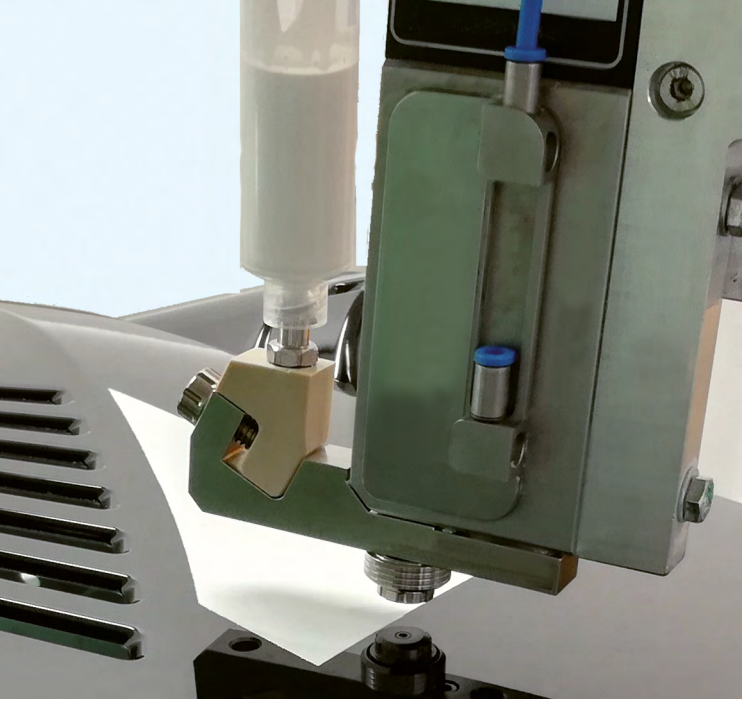
Coating paths can be programmed offline in order to define, simulate and optimize painting strategies and motion sequences for real-life implementation.

The robot is housed in a booth with adjustable supply and exhaust air volumes, thus ensuring that solvents and particles are reliably extracted. Offering maximum flexibility, the extraction unit can be positioned either horizontally or vertically.

Examples of application modules

Piezo jet valve (drop-on-demand process)
In this application module, free-flying drops (200 – 1000 µm in size) of coating material are generated , which then hit the surface at a distance of a few millimeters to centimeters with pinpoint accuracy. Lines or areas are created by stringing them together. Droplet generation is adjusted via the applicator's working parameters (pulse pattern, stroke height, nozzle diameter, needle geometry and material pressure) to match the materials to be coated. In contrast to conventional inkjet printing processes, it can be used to apply a wide range of coating materials - from low to high viscosity. A further integrated control option is the ability to heat the coating material. The use of ceramic components means that abrasive coating materials can also be processed. In addition, droplet delivery can be adaptively controlled as a function of the robot's real-time speed, which ensures uniform application of the coating.

Because it can generate single droplets, the piezo jet valve is also a valuable tool that can be used in basic research to



Selective, overspray-free application of a decorative coating.

understand interactions such as the influence of material properties, the processes involved in droplet impact, or as input variables for numerical simulations.

Precision spray nozzle
A special spray nozzle is provided for cases where coatings need to be precisely applied by spraying. Coating materials up to approx. 100 mPas can be microdosed and applied with pinpoint accuracy. The spray jet can be adjusted down to 2 mm, with a blurring range of 30 percent. The fine spray also enables extremely thin layers <1 µm to be applied evenly and precisely. It can also be used to create color gradations.

Understanding cause-effect relationships and influencing variables

High speed camera
A high-speed camera (with a resolution of up to 2 µm and a frame rate of over 30,000 images per second) can be deployed to determine suitable working parameters for the application modules. Via the camera, the influences of individual control variables on the drop shape, the drop break-off or the formation of any satellite droplets can be observed and analyzed.

Numerical simulations
Numerical simulations (fluid dynamics: volume of fluid) are performed to gain a deeper understanding of interrelationships, e.g. as regards droplet formation, optimum working areas for droplet formation or the flow of paint films (formation of paint layer structures). These findings are continuously incorporated into the further development of selective coating technologies.

Rheology
Understanding the shear properties and elongational viscosity of coatings – in conjunction with knowledge of other interactions – can help optimize coating systems for selective and overspray-free coating applications. With this in mind, the technical center is equipped with both rotational and capillary rheometers (with specially-developed IPA algorithms for evaluating elongational viscosity).

Services offered by Fraunhofer IPA

The Fraunhofer IPA microcoating plant can be used to carry out feasibility studies on paint systems (solvent- and water-based systems, 1-component and 2-component technology, UV-curing paints) and on customer parts. If necessary, adjustments can then be made to meet requirements, or materials modified in collaboration with the coating developers at IPA. In combination with the paint line in the same building, complex process chains (e.g. wet-on-wet processes) can also be put to the test. Developments such as the adaptation of effect paints for overspray-free coating are also currently underway.

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