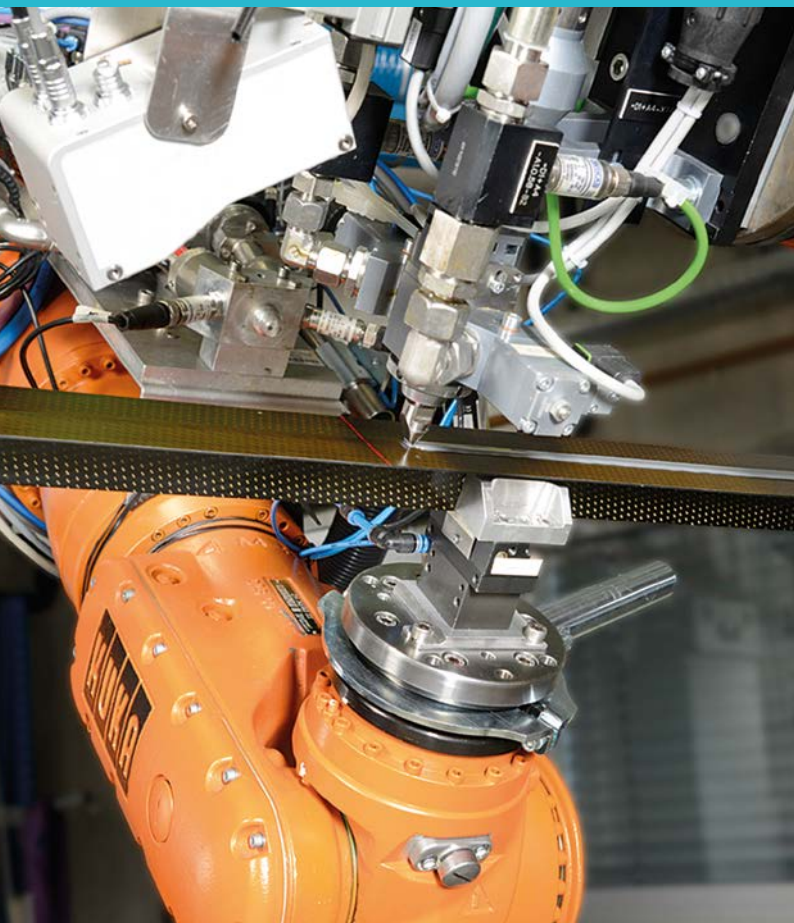
Fraunhofer
IFAM

FRAUNHOFER INSTITUTE FOR MANUFACTURING TECHNOLOGY AND ADVANCED MATERIALS IFAM

ADHESIVE BONDING TECHNOLOGY



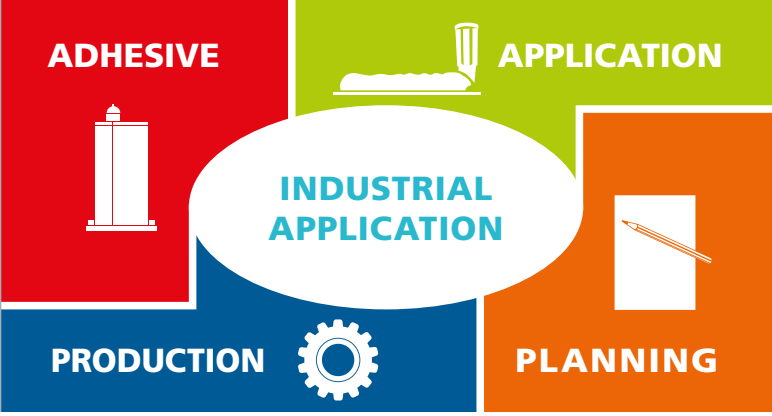
INDUSTRIAL APPLICATION

The quality of a bonded product is largely determined by the bonding process

Adhesive bonding as a joining technique puts high requirements on the adhesive, the application technique, the production planning, and the actual production. The overall representation of the process chain (see figure) highlights the interdisciplinary nature of adhesive bonding. Our pooled knowledge of chemistry, physics, and engineering allows us to develop customized bonding processes for a range of industries including:

- Automotive industry
- Aircraft manufacture
- Rail vehicle manufacture
- Plant construction
- Electrical engineering
- Microsystem technology and optics
- Construction industry
- Shipbuilding
- Special vehicle manufacture
- Packaging industry
- Tool manufacture
- Medical technology
- Textile industry

and other industries.



ACTIVITIES OF THE ADHESIVE BONDING TECHNOLOGY DEPARTMENT

Adhesive

- Adhesive selection and adhesive qualification/testing
- Ageing of adhesives
- Analysis of adhesives / thermal analysis and rheology
- Characterization of bonded joints

Application

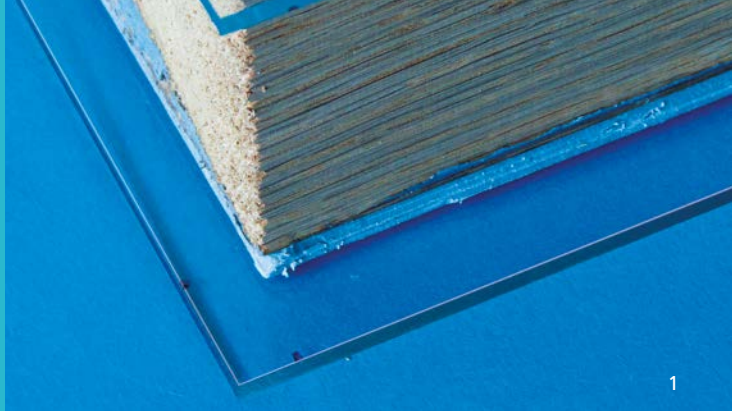
- Application technology for adhesive tape manufacture
- Development and optimization of nozzles for adhesive application
- Selection of mixing and dosing units
- Customer-specific application tests
- Adhesive application for micro-production
- Simulation of the flow behavior of adhesives

Planning

- Production concepts for bonded joints
- Virtual process planning for automated adhesive application
- Feasibility studies and economic considerations

Production

- Automated/manual adhesive application
- Robot-aided production
- Integration and optimization of bonding processes
- Quality assurance
- Fault/defect analysis and consultancy



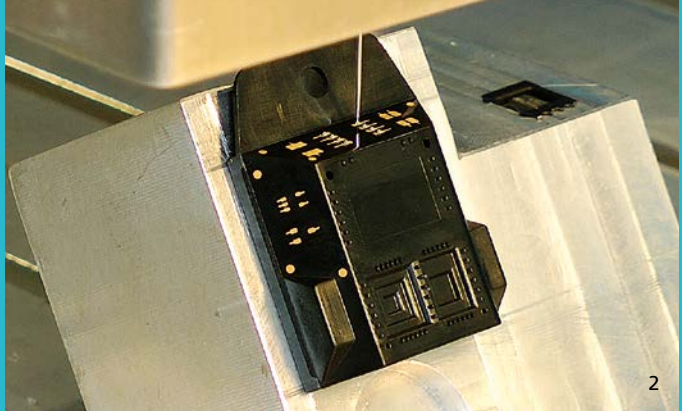
1

ADHESIVE

Before designing an adhesive bound or applying an adhesive all necessary requirements for the adhesive have to be known, especially production conditions and the entire life cycle of the adhesive. Boundary conditions are defined for selecting a suitable adhesive and the resulting bonded joints are evaluated in experimental tests. Ageing tests are carried out based on many years of practical experience of Fraunhofer IFAM in this area.

Adhesives can be used on a wide range of different design geometries, structures, and materials. The wood-glass bonded joint shown in Figure 1 is, for example, only possible using special adhesives.

When designing wooden structures, for example, the adhesive has to be fully characterized. In addition to mechanical properties such as the stiffness and strength, the flow properties are also measured. This approach allows selection of a suitable combination of adhesive and application method. Determination of the temperature-dependent behavior of the adhesive ensures, amongst other things, that bonded joints can withstand the highly variable temperatures encountered in the construction sector.



2

APPLICATION

Fraunhofer IFAM engineers customize the mixing technique and application method to the particular bonding task and the adhesive being used. For example, follower plates and scoop piston pumps are used for large containers of highly viscous and paste-like adhesives. In order to ensure optimal mixing of two-component systems, a mixing unit is integrated with the dosing system. The precision application of the adhesive is guaranteed by nozzles having suitable geometries.

Additionally to the commonly used bead application method, Fraunhofer IFAM uses a range of different application methods including spraying, potting- and spot application. Application of very small amounts of adhesive is accomplished by pressure-time dosing, screen printing, stencil printing, stamp printing, and use of jet valves.

In 3D-MID[1] production (Figure 2), the solder paste alone cannot maintain the position of larger electronic components when traveling to different mounting orientations. To aid positioning, two spots of hotmelt are therefore applied using a jet valve.

[1] *Molded Interconnect Devices*

PLANNING

The integration of tailored adhesive application methods requires careful selection and coupling of production equipment. Starting from a concept for the process chain, virtual tools are used to evaluate the feasibility of selected process steps. Customer-specific production conditions are visualized and optimized using 3D simulation (Figure 3). The entire process chain is then validated using original components in the production pilot plant at Fraunhofer IFAM.

The suitability of the adhesive dosing system and application method are tested at an early stage of the production planning. In addition, robot and portal systems are integrated and sensor technology for the automation is appraised.

In all cases, the specialists in the Adhesive Bonding Technology department endeavor custom to find the optimum price-performance ratio for the given resources. We use our developed cost calculating software to determine production and investment expense. The results are summarized in a transparent way for our customers in order to aid their decision-making.

4

PRODUCTION

The production of bonded joints can be carried out manually or with varying degrees of automation. The Adhesive Bonding Technology department at Fraunhofer IFAM develops customer-specific production concepts which are validated via prototype production. On-site analysis of existing customer processes is carried out, with consideration of the total product life cycle. Optimization measures for reducing the cycle time, costs, and production errors are identified.

Due to strict regulations for rail vehicle manufacture, relevant bonding processes (Figure 4) in that industry must comply with DIN 6701. The implementation of optimization measures has demonstrably improved the quality of bonded joints on rail vehicles. Any abnormal specifications, which could lead to product rejection, are detected at an earlier stage of the production. For other industries, the DIN 2304 standard specifies the quality assurance requirements for bonding processes. Fraunhofer IFAM specialists assist customers with the implementation of these standards.

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