



1 Demonstrator for ultrasonic testing of a bonded glass pane.

ADHESIVELY BONDED JOINTS – QUALITY ASSURANCE BY NON-DESTRUCTIVE TESTING (NDT)

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Adhesive bonding technology in industry

Adhesive bonding is being increasingly employed in all industrial production processes. It allows efficient, durable joining of virtually all combinations of materials. Even difficult material combinations that have until now been difficult to join, like the joining of different metals as well as the joining of metals with glass or fiber composite materials. Adhesive bonding technology hence permits modern, specialized materials to be used for hybrid and lightweight structures using innovative design concepts.

Quality assurance for adhesive bonding technology

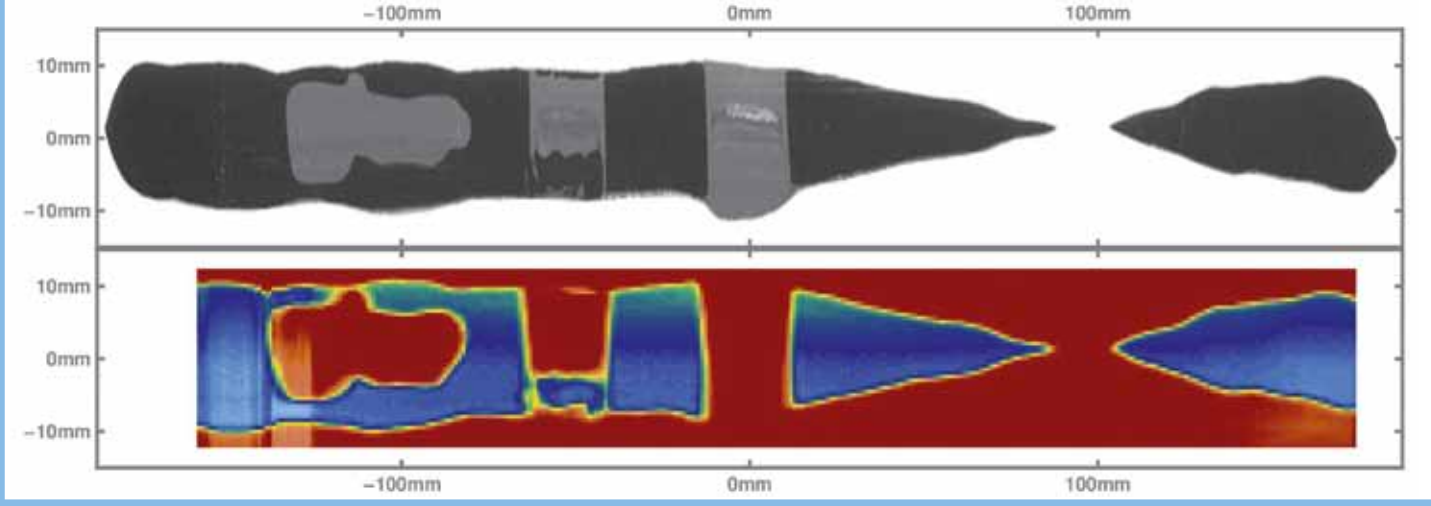
According to DIN EN ISO 9001, adhesive bonding technology is a “special process”, i. e. the quality of the bonded joints must

be assured by use of specific methods and procedures. This can comprise suitable process monitoring, destructive tests on random specimens, and also non-destructive testing (NDT).

Non-destructive testing in adhesive bonding technology

Non-destructive testing covers a wide range of different methods. Most of them were developed for examining metallic materials and have only limited use for testing plastics and, in particular, bonded joints.

The Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM is addressing this shortcoming by putting a focus on quality assurance methods for bonded joints. In addition to modifying and optimizing established non-destructive methods, new innovative measuring principles



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are being tested for their suitability for bonded joints.

Ultrasonic testing

Ultrasound has been used for decades for non-destructive testing. However, its potential has been considerably enhanced in recent years due to the development of novel algorithms for analysis and new test equipment, for example, phased array technology.

Ultrasound testing is particularly well established for metallic materials, but can also be used for quality assurance of plastics and, in particular, bonded joints.

Besides manual ultrasonic testing, as often used for maintenance and repair, the technology can be easily automated. Hence in production the testing of up to 100 % of the manufactured items can be achieved, whilst simultaneously maintaining the desired cycle times.

Practical example – NDT of bonded glass joints

Glass panes in car and rail vehicle construction are often bonded to the body using thick-film, polyurethane-based adhesives. For reliable bonding an adequate wetting of the glass by the adhesive is essential. The adhesive bead is not visible through the black mask in the edge region of the glass and hence visual inspection is not possible. The solution here is to use ultrasonic testing.

To exemplify the method, a demonstrator was built at Fraunhofer IFAM. It contains a defective bonded joint that is automatically tested using a phased-array ultrasonic sensor moved by a linear axis (Fig. 1). The defects induce a pronounced change in the amplitude of the ultrasound reflected by the adhesive bead. This allows detection of wetting errors or detection of insufficient application of adhesive (Fig. 2).

Portfolio of NDT methods at the Fraunhofer IFAM

- | Ultrasonic testing – conventional and phased-array
- | Thermography
- | X-ray computer tomography
- | Acoustic emission analysis
- | Fokker bond tester
- | 3D shape measurement, e. g. by laser triangulation

Other methods in collaboration with partner institutes

- | Shearography
- | Terahertz spectroscopy
- | Laser ultrasonic testing
- | Eddy-current testing

2 Top: Adhesive bead with defects. Below: Ultrasonic testing clearly indicates defects in the adhesive bead.