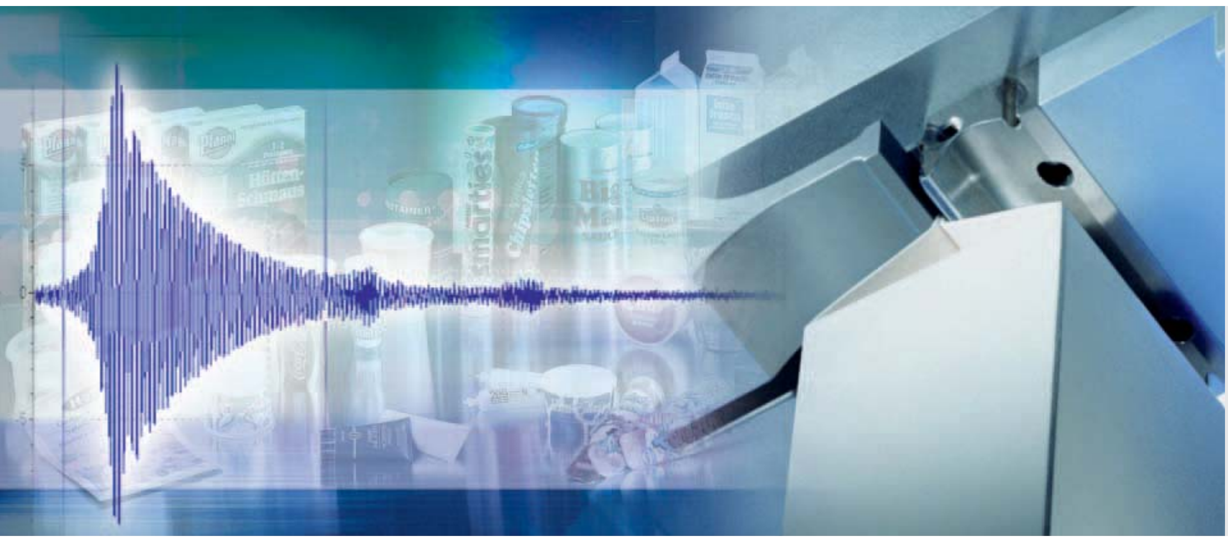
Application Note

Polytec

Optimization of Ultrasonic Tools



Field of Application

- A Aerospace
- B Audio & Acoustics
- C Automotive
- D Data Storage
- G General Vibrometry
- M MEMS & Microstructures
- **P Production Testing**
- S Scientific & Medical
- T Structural Testing
- U Ultrasonics

Laser Vibrometers Help Optimize Production of Ultrasonic Welding Tools for Joining Thermoplastic Materials

Ultrasonic welding is well established in the plastics processing industry. This technology allows high process speeds with constant, reproducible weld quality and low energy requirements. For this reason, it is preferred for high volume production applications in the automobile, electrical, medical, packaging, semiconductor and textile industries. Polytec single point and scanning vibrometers help develop optimal ultrasonic welding tools.

Introduction

In contrast to alternative technologies, such as gluing or thermal welding, ultrasonic welding does not have any impact on the material properties. In addition, ultrasonic technology allows multilayer welding or laminating and several process steps can be carried out in a single step, such as welding, cutting and perforating.

Herrmann Ultrasonics in Karlsbad, Germany, is a specialist in joining thermoplastic materials using ultrasound. Within the Plastics, Packaging and Non-wovens business units, customer-specific solutions are found for a wide range of ultrasonic welding applications.

This is How it Works

During ultrasonic welding, mechanical vibrations are transferred to the plastic parts under pressure. Warmth is generated through molecular and interfacial friction which increases the attenuation coefficient of the material. Locally, the plastic begins to soften. This reaction is self-accelerating due to the increase in the attenuation of the plasticized material, and a large share of the vibration energy is converted into heat. After welding and while maintaining joint pressure, a short cool-off phase is necessary to homogeneously solidify the formerly plasticized material. Subsequently the parts or rolls of material now joined together with the aid of the ultrasonic energy can be further processed.

The ultrasonic welding process is started with a stack. The stack is made up of a piezoelectric converter A, the amplitude transformation piece B and the actual sonotrode C (Figure 1).

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High Quality Requirements

A prerequisite for good welding results with regards to stability, density and optical quality of joints is joint tools designed to suit both the process and the material. The vibrational properties of the individual components are of particular importance here, in particular the vibration amplitudes. All components of the ultrasonic stack are tested as individual units at Herrmann Ultrasonics. The amplitude measurement is of utmost importance.

Measuring the Vibration Amplitudes

Depending on which individual component is at issue, its vibration amplitudes are verified using a Polytec single point or a Scanning Vibrometer.

Converter and transformation pieces are commercially available, standard components with fixed, tightly specified output vibration amplitudes. The vibration amplitudes are tested by making measurements with a Polytec CLV Compact Laser Vibrometer, thus ensuring that they are within the specified range.

Sonotrodes are individual components adapted to match the work piece to be welded. These components must fit the work piece geometrically and provide critical ultrasonic amplitude levels sufficiently high to produce good welds. A 3-D CAD model (Figure 2) is used to develop and design the sonotrodes by prototyping them on the work piece. The vibrational properties are then optimized with the aid of Finite Element Model (FEM) analysis until they fulfill the given parameters. Only then does the sonotrode go into production.

The properties of the finished sonotrode are measured with the aid of a PSV-400 Scanning Vibrometer. In Figure 3 the measurement layout is shown; on the left is the PSV-400 Sensor Head, on the right the sonotrode in a suitable holder

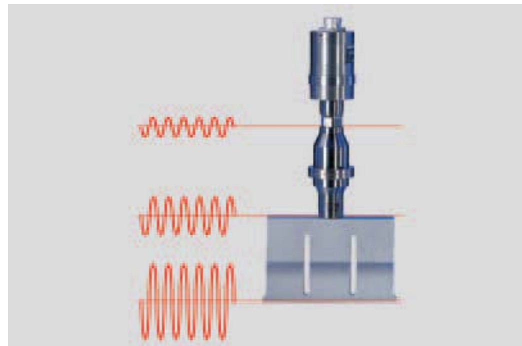

Figure 1: Design of the stack. The vibration amplitude (red) is being boosted on its way from the converter (A) to the sonotrode (C).

and in the middle the measurement screen with the video image of the sonotrode surface in the PSV Software.

The amplitudes occurring at a certain frequency are measured using the PSV-400 Scanning Vibrometer on selected points of the sonotrode surface (Figure 4). Specially configured software for this measurement saves time, allows safe operation and provides documentation. The amplitude distribution thus defined is compared with the value calculated from the FE model. So if necessary, the sonotrode can be further optimized.

For more information please contact your local Polytec sales/application engineer or visit our web page **www.polytec.com/industrial**

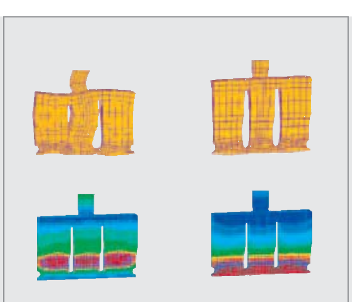

Figure 2: Modeling the dynamic behavior of a sonotrode

Figure 3: Measurement layout to characterize the sonotrodes

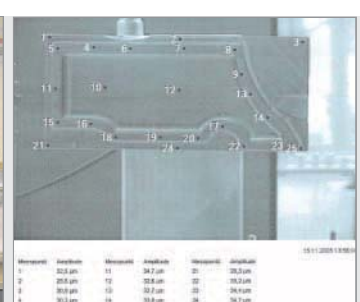

Figure 4: Amplitude distribution on the surface of the sonotrode

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