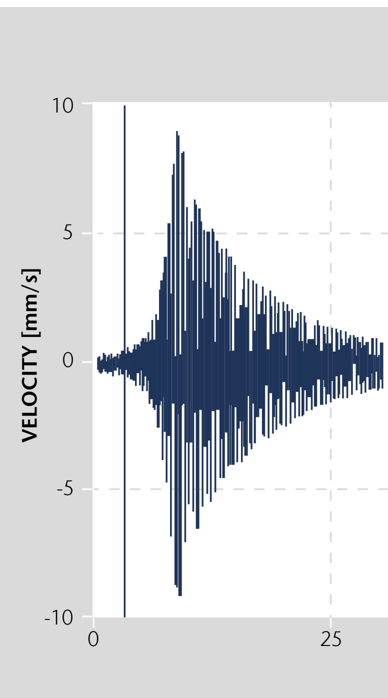


Optimizing Ultrasonic Tools

Vibration Measurement in Sonotrode Development

Application Note

Laser Vibrometers Help in the Development of Ultrasonic Welding Tools for Thermoplastic Materials

Ultrasonic welding is well established in the plastics processing industry. This technology allows high process speeds with a constant, reproducible welding quality with low energy consumption. For this reason, this manufacturing technique is preferred for high volume production applications in the automobile, electrical, medical, packaging, semiconductor and textile industries. Single-point and scanning vibrometers by Polytec help develop premium tools for ultrasonic welding.

Bonding Technique Using Ultrasonic

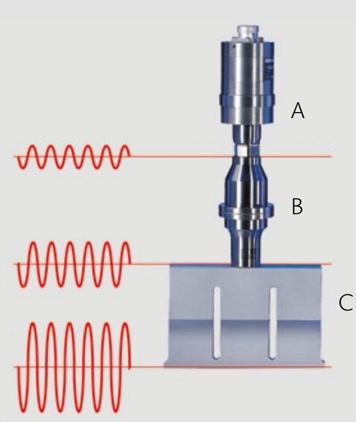
In contrast to alternative technologies, such as gluing or thermal welding, ultrasonic welding does not affect the material properties. In addition, the ultrasonic welding technology allows multilayer welding or laminating conducting several process steps at the same time, such as welding, cutting and 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.

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 damping co-efficient of the material. Locally, the plastic begins to soften. This reaction is self-accelerating due to the increase in the damping 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 for homogeneously solidifying 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).



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

High Quality Requirements

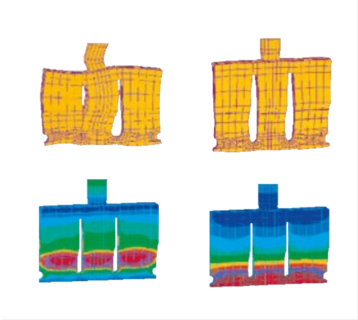
A prerequisite for good welding results regarding stability, density and optical quality of joints is a joint tool that suits both the process and the material. The vibrational properties of the individual components are of particular importance here, especially the vibration amplitudes. All components 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 the component, a single-point vibration measurement or a scanning measurement is used.

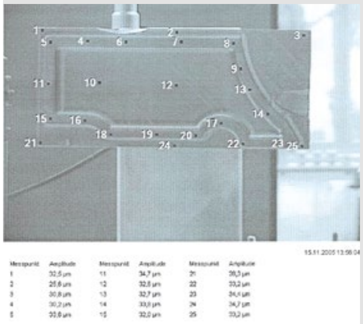
Converter and transformation pieces are commercially available standard components with fixed, clearly specified output vibration amplitudes. The vibration amplitudes are tested by making measurements with a Polytec CLV Compact Laser Vibrometer, thus ensuring to stay within the specified range. Sonotrodes are individual components adapted to match the work piece to be welded. These components must fit the work piece perfectly for providing the relevant ultrasonic amplitude level in order to assure a good welding process. A 3D 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 by a PSV Polytec Scanning Vibrometer. In figure 3 the measurement layout is shown; with the PSV sensor head on the left-hand side; on the right-hand side the sonotrode in a suitable holder 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 a PSV 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 resulting amplitude distribution is compared again with the values from the FE model. So if necessary, the sonotrode can be further optimized.



2
FE modelling of the dynamic behaviour (above) and of the strain distribution (below) of a sonotrode

3
Measurement layout to characterize the sonotrodes



4
Amplitude distribution on the surface of the sonotrode

Cover image shows a sonotrode, source Herrmann Ultraschalltechnik GmbH & Co. KG, Karlsbad

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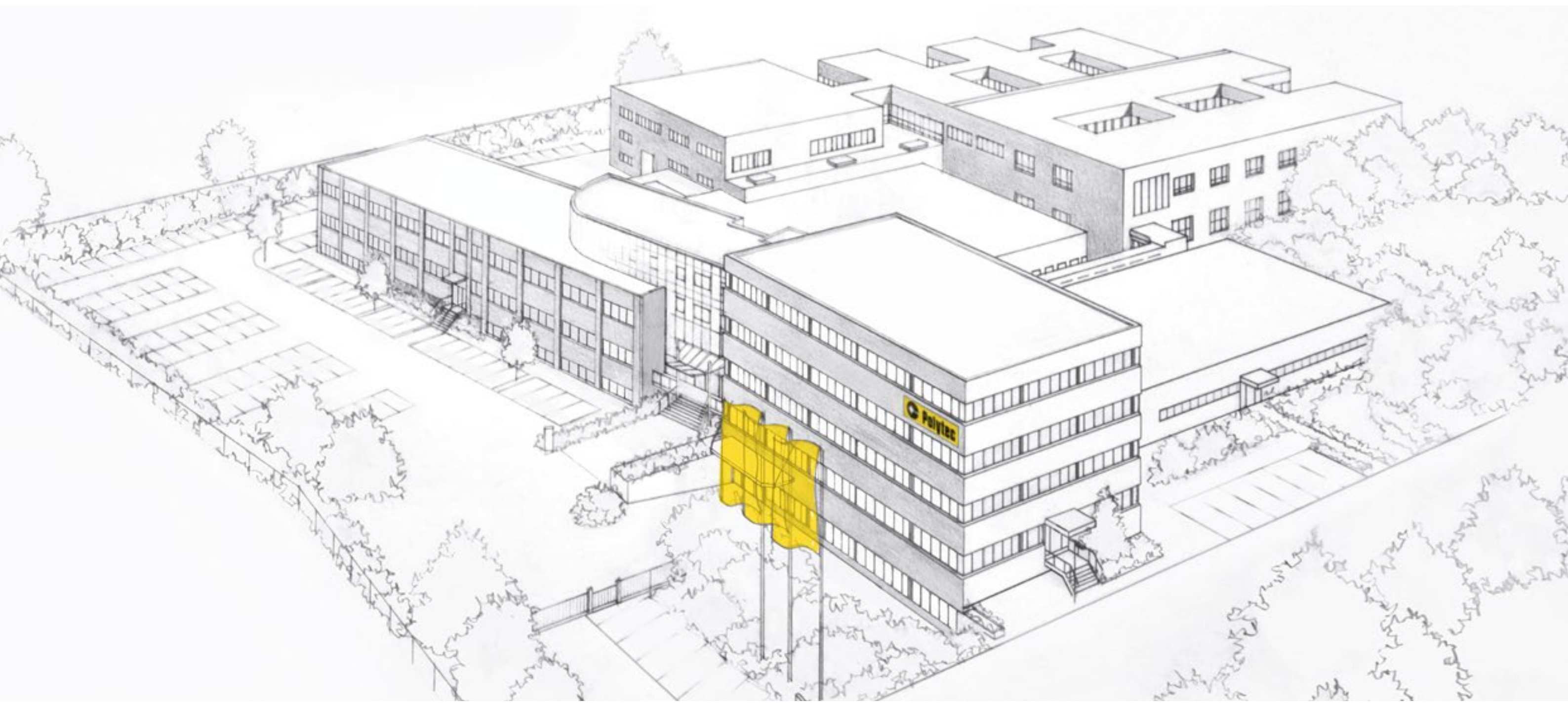

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