Ultrasonics and PPE / Medical Devices

Please wait while attendees join the webinar
Sonics personnel in attendance

Lauren Soloff - President
Brian Gourley – National Sales Mgr
Dave Krysiak – Metal Welding Technology Mgr
Bill Aurand – Packaging Technology Mgr
Due to the large number of attendees registered, microphones will be muted to minimize distractions.

Questions can be sent via the “Questions” tab and will be addressed at the end of the presentation.
Note that any questions entered cannot be seen by other attendees.

Questions of a sensitive or proprietary nature can be sent via email to webinars@sonics.com
Ultrasonic Welding Webinar for PPE and Medical Device Manufacturing

First, who is Sonics and Materials?
Technology leader in high power ultrasonic technology since 1969
Father of ultrasonic welding

Just the facts

WHO IS HE? Bob Soloff, founder of Sonics & Materials Inc.
HEADQUARTERS Monticello, Germ
EMPLOYEES 75
PAYING THE WAY Method of Welding: Thermodynamics; Form in 1965; plus
ACCOUNTS RECEIVABLE
EDUCATION: B.S. in mechanical engineering, The Cooper Union; M.S. in Management of Science and Art, New York

Your invention of ultrasonic welding has been significant for the plastics industry. Can you tell us the story of the discovery?

Bob Soloff: An anechoic chamber in our lab was one of the first things I was working on. It was a project started with ultrasonics for different applications, and I was assembling and disassembling probes that would work on hard plastics. I was trying to find a way to weld those two halves together. That's where I had the "aha moment" that made it work with other plastics, too.

I built a transducer and a Horn to work with the ultrasonic waves. I took a pair of toys and put them together — then used the transducer and the horn. I put the two halves together. That's how the ultrasonic welding was born.

How did you bring your invention to market?

SOLOFF, Page 84
In order to understand the ultrasonic welding process and its capabilities in regards to PPE manufacturing, we will explore the following:

• Ultrasonic Welding Process Theory

• Main Components of an Ultrasonic Welding System

• Basic Principles of Ultrasonic Tooling Design

• Ultrasonic Welding Process Parameters

• Ultrasonic Bonding Applications for PPE and Medical Devices
What is ultrasound?

Ultrasound is defined as acoustical vibration above the range of human hearing.

Humans can hear frequencies as low as 20Hz and as high as 20kHz.

Sonics utilizes the following frequencies for various ultrasonic welding and cutting applications: 15kHz, 20kHz, 30kHz, 35kHz and 40kHz.
FREQUENCY:
Frequency is the rate at which the Converter/Booster/Horn assembly expands and contracts (40,000 vibrations per second for 40kHz or 20,000 vibrations per second for 20kHz)

AMPLITUDE:
Amplitude refers to the specific distance that the face of a vibrating component travels during expansion and contraction. Typical welding amplitude requirements are between 30µm and 100µm (peak-to-peak) at the horn surface, depending upon the frequency and plastic material being bonded.
NODAL PLANE:
The Nodal Plane is the point near the center of each vibrating tool where the least amount of longitudinal expansion/contraction occurs and the greatest amount of radial expansion/contraction occurs.

GAIN:
Gain is the term used to described the amplification factor of a booster or horn. Gain is determined by the mass ratio on opposing sides of the nodal plane.
What is Ultrasonic Sealing?

A secondary assembly process whereby high-frequency mechanical vibration is applied to thermoplastic materials under pressure to create intermolecular frictional heat, resulting in a molecular bond.
How Does The Process Work?

Clamp Force → Vibration → Friction → Heat → Melt → Weld
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- Ultrasonic sealing process parameters
- Ultrasonic sealing applications for PPE and Medical Devices
Components of an Ultrasonic Sealing System
Conversion Of Electrical To Mechanical

20,000 Hz
1300 volts

50 / 60 Hz
120 / 240 volts

GX-Series Power Supply**

Ultrasonic “stack”
(converter – booster – horn)
Ultrasonic generators can be as simple as a PC board or as advanced as a microprocessor.

Key features of a Sonics ultrasonic generator:

- Continuous ultrasonic signal or with stop conditions as required by the application
- Automatic frequency tracking to maximize efficiency and process stability
- Line and load regulation provide constant amplitude
- Amplitude adjustment
- Horn start rate adjustment
The converter is a device that converts electrical energy into mechanical movement.
Within the converter, piezoelectric ceramic discs are compressed between tuned front and rear drivers. These ceramic crystals expand and contract when the high voltage from the generator is applied, producing mechanical vibration.

20 µm peak-to-peak in 20 kHz
How big is a micron?

- Micron
- Human Hair
Converters come in many configurations, depending upon the application.

Note: A converter functions in both directions. For this reason, metal to metal contact should be avoided as it can potentially deliver a high voltage electrical charge back into generator.
• Boosters are available in a variety of amplification values
• In addition to amplitude adjustment, boosters also provide a non-vibrating clamping point for mounting the ultrasonic stack
Boosters function based upon the amount of mass on opposing sides of the nodal area.

Depending on this mass relationship, boosters can increase or decrease the amplitude from the converter.

Note: Newer technology generators are also capable of increasing or decreasing the process amplitude via a digital setting.
In some applications rigid mount, one-piece boosters are used for the enhanced rigidity they provide. Further, their titanium construction complies with the sanitary and wash-down requirements of the food packaging industry.
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Ultrasonic horns, (also called Sonotrodes) are acoustical tools that are custom-designed and tuned for each application.

Horns transfer the ultrasonic vibration to the parts under force.
Horns are manufactured and analyzed using sophisticated measurement technology to confirm their functional capability.
Properly manufactured horns provide:

- Single frequency within the operating range of the generator
- Wide bandwidth to facilitate generator tuning and frequency tracking
Finite Element Analysis (FEA) computer modeling systems are used for state-of-the-art horn design.

FEA allows us to:

• Optimize the resonant frequency of a horn by eliminating secondary frequencies that would cause the horn to vibrate in an unproductive mode.
• Minimize the mechanical stress in the horn, providing longer tool life.
• Create horns with even amplitude distribution throughout the entire weld surface.
Amplitude increase
Titanium – provides excellent fatigue resistance. Titanium is the material of choice for most ultrasonic horns.

Aluminum – has excellent heat transfer properties but usually requires a coating to enhance wear resistance.

CPM10V – is a sintered steel that also provides excellent wear resistance.
Aluminum horn coatings to improve their wear characteristics

- Nickel
- Chrome
- Hard Anodized
- Carbide
• Support the weld by opposing the vibrating horn with sufficient mass to stop the ultrasonic vibration

• In sealing flexible materials, the anvil must also focus the frictional energy via a seal bead pattern across the length of the material
Sealing Bead Design
- Support the weld by opposing the vibrating horn with sufficient mass to stop the ultrasonic vibration

- In sealing flexible materials, the anvil must also focus the frictional energy via a seal bead pattern across the length of the material

- Means of Leveling
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The process variables in ultrasonic sealing are closely related to those in conventional heat sealing: Seal Time, Seal Force, Seal Temperature (Amplitude)

- **Seal Time** - How long the ultrasonic vibration is applied to the material
- **Seal Force** – Clamping force between the vibrating horn and non-vibrating anvil
- **Seal Amplitude** – Distance of vibration at the face of the weld horn

A programmed weld parameter determines the duration of vibration.
- **Time**
- **Energy**
Material enters the seal area
Sequence of Events

Tools close
Force builds up without vibration
Ultrasonic vibration is applied

Sequence of Events

U/S Vibrations
Friction
Heat
Melt
Sequence of Events

Vibration ceases

U/S Vibrations
Friction
Heat
Melt
Weld
How can ultrasonic equipment be used in manufacturing?
Ultrasonic benchtop press systems can be utilized for hand load/unload operations as well as some automated applications.

Ideal for ear loop welding and plunge sealing straight stitch lines up to 12" (320mm) long, as well as driving threaded brass inserts.

Presses can also be used in continuous sealing applications with specialized tooling.
Simple rotating anvil components can be used to turn a benchtop welding press into a continuous sealing ultrasonic sewing machine.
Ultrasonic components are an excellent way to achieve high speed continuous seals when integrated into custom automated machinery.
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Kit generators can be driven by the machine’s PLC as an more cost effective way to apply ultrasonic technology.
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- **Ultrasonic sealing applications for PPE and Medical Devices**
Applications Videos

• Nonwoven bonding
• Face Mask Manufacturing
• Driving Brass Inserts
The link below contains good information regarding the construction and requirements of face masks.

You can copy and paste it from the “Chat“ tab

Continuous stitching application requirements

• Ultrasonic energy is continuously applied with flat faced vibrating tools

• Rotary anvils with stitch patterns or engraved drums oppose the weld horns (Flatness and runout must be held to tight specifications to ensure a uniform seal)

• Floating application of force in either the ultrasonic stack or rotary anvil

• Positive stop to prevent metal to metal contact of the tools
Face Mask Applications
Face Mask Applications
Ear loop welding application requirements

- Plunge application of ultrasonic tools
- Timed ultrasonic weld start and stop
- Rigid steel anvil to oppose the vibrating tools
Driving brass inserts application requirements

• Plunge application of ultrasonic tools

• Ultrasonic weld start and stop controlled by time or position

• Positive stop may be engaged to hold precise insert height

• Rigid support beneath the plastic parts to eliminate loss of vibratory energy
Question discussion
Additional Questions?

Questions regarding sensitive or proprietary subjects can be addressed via email to webinars@sonics.com
Thank You