Pacific Northwest
NATIONAL LABORATORY

One of the most promising commercial applications for this patented technology may be to monitor the manufacture of lithium-ion batteries. It's currently available for licensing in all industrial markets.

CHARACTERIZING THE QUALITY OF ULTRASONIC WELD BONDS

Acoustic sensors find and prevent defects

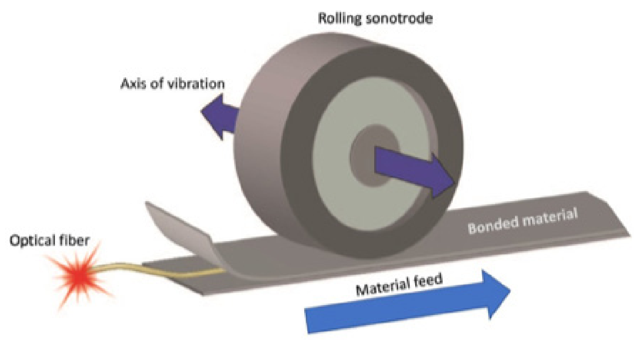
DETECTING DEFECTS WITHOUT DAMAGE

Ultrasonic welding uses sound waves and high pressure to bond metal foils or sheets at relatively low temperatures. Unfortunately, surface contaminants can be inadvertently introduced into the weld region during this process, impacting weld quality.

Pacific Northwest National Laboratory's (PNNL) acoustic sensor uses nondestructive examination techniques to monitor weld quality in real time and identify perfect, weak, and failed bonds. The technique combines information theory and machine learning to quickly identify defects. The method makes it easier to reliably weld dissimilar materials, alloys, or composites and could replace traditional destructive quality measurement methods.

TECHNOLOGY FEATURES

- Does not contaminate or degrade material
- Easily incorporated into current ultrasonic welding systems
- Improves efficiency through real-time measurements and process adjustments from machine learning
- Works on a wide variety of metals and alloys
- Beneficial for use in electrical, computer, automotive, aerospace, nuclear, and medical industries



This illustration depicts a rolling ultrasonic welder bonding, an optical fiber sensor between two metal foils. PNNL's monitoring technology makes it more reliable to manufacture bonds around embedded sensors. The sensors themselves can be used to confirm that the weld was completed successfully.

SO MANY WELDS, SO LITTLE TIME

Current industrial weld monitoring practices lack the ability to quickly check the quality of every weld performed in a production line in a nondestructive manner. Welding parameters are typically fixed when setting up a manufacturing process and can't be updated to adjust for changing conditions. Even small variations in raw materials and environmental conditions can result in a poor-quality bond.

GOOD AND BAD BONDS

Contaminants introduced during the ultrasonic welding process can significantly impact bond formation, strength, and durability. PNNL's acoustic sensor monitors weld quality to identify a true bonding of the metal pieces, a softening or light adhering of one or more of the pieces, or a failed bond.

The device measures acoustic signals or vibrations in materials throughout the welding process and analyzes the data in real time to predict or determine the quality of the weld, or bond. The results of this nondestructive analysis are expressed as a bond quality index value; the higher the value, the more perfect the bond. These data, combined with feedback from machine learning, allow weld settings to be adjusted to prevent defects.

With machine learning, monitoring and checking the quality of every ultrasonic weld can make it easier to reliably weld dissimilar materials, alloys, or composites, such as those used in advanced manufacturing. Monitoring the process also simplifies the production of complex three-dimensional structures with ultrasonic additive manufacturing. Weld settings that would normally require testing and verification at each step can now be determined "on the fly."

WHAT MAKES IT UNIQUE

A weld can be considered perfect only when the resultant bond is as strong as the bulk material. There are many ways to measure this, and each approach has trade-offs. Traditionally, the test would involve removing a few test pieces from a production line and pulling them apart to measure the bond strength. The acoustic sensor, with multiple rapid data analysis techniques including information theory and machine learning, can replace traditional destructive quality measurement methods and make it easier to reliably weld dissimilar materials, alloys, or composites. And because the sensors reside within the existing process, the feedback loop is nearly instantaneous.

INDUSTRY APPLICATIONS

PNNL's ultrasonic weld monitoring approach can be used with a wide variety of metals and their alloys, including aluminum, copper, gold, iron, magnesium, molybdenum, nickel, platinum, silver, titanium, and tungsten. The approach could be used in the electrical, computer, automotive, aerospace, nuclear, and medical industries. One of the most promising commercial applications may be to monitor the manufacture of lithium-ion batteries.

AVAILABLE FOR LICENSING

The acoustic monitoring device is available for licensing in all fields.

LET'S CONNECT

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