Through the Tool Tracking for Friction Stir Welding

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CTTC Center for Technology Transfer & Commercialization

Summary

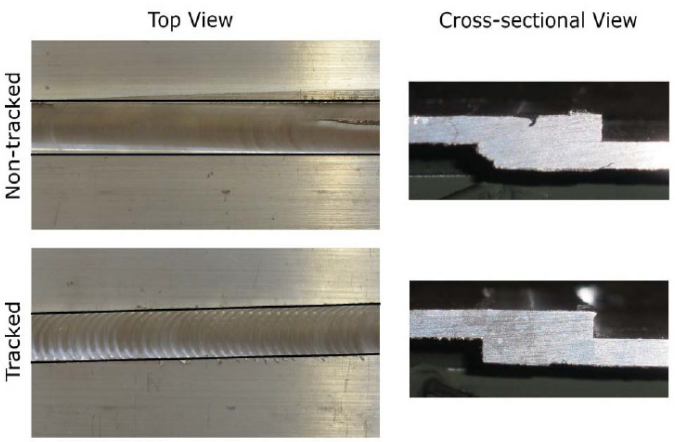
Friction Stir Welding (FSW) is increasingly gaining ground in a variety of critical welding applications. Vanderbilt inventors have developed a technique to keep a weld tool on track by utilizing only force sensors on the friction stir welding tool. This technology is especially beneficial in real time corrections for deviations in travel in the case of robotic FSW or "blind" welds. The technique is cost-effective in that no additional sensors such as cameras, thermocouples, acoustic emission receivers, etc. are required.

Technology Description

FSW was developed in 1991 by the Welding Institute in the UK. It is a solid state process where welding is accomplished via mechanical stirring below the melting point of the material. In FSW, the welding tool consists of a shoulder and a pin, or probe, and the tool is rotated while traversing the weld line. The shoulder applies pressure and heat to the surface of the material while the probe plunges into the material and induces material flow. Vanderbilt research has led to the development of a misalignment detection and correction system for FSW. This technology detects misalignment by monitoring the forces recorded by a dynamometer attached to the tool itself.

A straightforward application of misalignment detection is as a means of verification that the FSW tool is properly aligned. This could alert an operator if a misalignment is detected, which could have serious effects on the weld quality. Another compelling use for misalignment detection is as part of a greater system called "Through the Tool Tracking." In this system, misalignment detection is used as a feedback signal for a closed loop lateral position control system. In Through the Tool Tracking, a closed loop control system is established using the previously discussed misalignment detection algorithm.

In Through the Tool Tracking, the estimated lateral offset is input into a controller system, which then uses this information to control the positioning motors. The weld controller is a standard feedback control system that strives to maintain some desired state, and this system is then used to actively maintain a lateral position. This is very useful when either the actual lateral position is difficult to obtain precisely through other means (T-joints) or when the joint line is not a straight line, as might be the case in robotic FSW. Through the Tool Tracking thus represents a means of automatic joint line tracking for FSW. This technology is in use in other welding methods, such as arc welding where the electrical arc signals are used rather than force signals, but not yet in FSW.



This montage depicts the efficacy of the Vanderbilt technology in improving the tracking and quality of the FSW weld.

Advantages

The use of Through the Tool Tracking to enable joint line tracking in FSW is an important development for FSW. This technology is expected to improve the robustness of the FSW process by enabling fidelity of complicated weld-seams not only in visible tracks, but also in "blind" tracks, as in T-joints. System cost and complexity does not increase substantially due to the need for only tool mounted force sensors.

Intellectual Property Status

Three Issued US Patents No.s 7,850,057, 8,052,034, 8,191,753

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Link to Vanderbilt technologies available for licensing