Quantitative Analysis of Heat Transfer Coefficient for Friction Stir Welding Temperature Profiles

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Friction stir welding (FSW) is a solid state welding process that takes place below the melting point of the materials to be joined, and the quality of the resulting weld is based on the material temperature. When modeling FSW, there are two key factors that have yet to be experimentally measured: the friction coefficient (μ) and the heat transfer coefficient (h). The current practice is to tune μ after selecting h values based on two often cited papers from 2003, but the original authors specify multiple times that the values they obtain are very approximate. This presentation details three efforts to validate a fiber optic, thermoreflectance system to measure the heat transfer coefficient during FSW. The system has been shown to measure thermal properties but not the heat transfer coefficient between the tool and workpiece during FSW. Initial results from the research include the design and manufacture of a FSW tool that can incorporate fiber optics into it. Additionally, we have validated the measurement system on a gold coated euro coin. We also have quantified the effect of the heat transfer coefficient on the temperature profile of a FORGE simulation model. Ongoing work includes, validating and calibrating the measurement system at different pressures. To simulate the FSW environment the aluminum and H13 steel pucks will be in a vice to simulate the pressure experience during FSW. These measurements will give us a base line to compare measurements when the system is used in a FSW situation in future work, which requires further development. This will allow the heat transfer coefficient to be directly measured for the first time during a solid state welding process. This project will provide new information on the heat transfer coefficient that will improve current models of FSW tool and improve welds made through this process.