Validation of 3ω-based sensor to measure the heat transfer coefficient between a friction stir welding tool and workpiece

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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's 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) [W/m2K] between the workpiece and the tool. The current practice when simulating the FSW process is to tune μ after selecting h values based on two often cited papers from 2003; however, the original authors specify multiple times that the values they obtain are very approximate. The current research presents the first steps towards this h measurement, namely (1) validating the 3ω instrumentation by measuring the thermal conductivity of polyethylene glycol diacrylate (PEGDA) surrounding a thin wire, and (2) validating a multi-layer 3ω model to determine the thermal contact conductance between a thin film 3ω sensor on a substrate and aluminum 6061 at a range of pressures. Future work will be integrating this thin film sensor into a FSW machine to conduct measurements during a weld.