Thermal Modeling and Experimentation for Residual Stress Prediction in Braze-Welded Beryllium via a Surrogate CuZn10 Alloy

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Thermal stresses arise during welding processes and often lead to significant residual stresses in welded structures. These residual stresses can adversely affect part performance by accelerating stress corrosion cracking, hydrogen-induced cracking and fatigue cracking. For this reason, it is useful to predict residual stresses through simulations of the welding process. A method is being developed for predicting residual stresses created during braze welding of Beryllium. As part of the method, Gas Metal Arc Welding (GMAW) experiments are being conducted using a CuZn10 (90% Cu with 10% Zn, by weight) alloy, which serves as a surrogate that closely matches the thermal properties for Beryllium. Controlled welding takes place on a custom-designed welding test station that is equipped to collect temperature data from welding specimens via thermocouple measurements and an infrared camera. Temperature data are compared with computational (Finite Volume) and analytical results. Temperature history data collected at specific locations are combined with model predictions to estimate the full temperature field history surrounding the weld zone. These results serve as inputs into models of structural behavior for the prediction of residual stress fields produced by the braze-welding operation.