abst. 2197
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## Probabilistic Approach for Thermoelastic Signal Source Identification in Carbon Fiber/Epoxy Composite Materials using Digital Image Correlation


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The successful quantification of the small temperature changes detected in a composite structure under isentropic loading conditions into strain variations using Thermoelastic Stress Analysis (TSA) is strongly dependent upon the proper selection of an analytical thermoelastic model. The conventional approach for thermoelastic model selection relies on the information provided by local strain measurement techniques, such as strain gauges or extensometers, hence limiting the characterization of the structural thermoelastic behavior to a single model. Moreover, a deterministic approach to quantify the thermal and mechanical properties built-in the thermoelastic model equations has been traditionally considered. This methodology reveals unsatisfactory to account for the composite material's inherent heterogeneity and seize the full-field capabilities of infrared cameras. This work proposes an alternative local-based probabilistic approach for characterization of thermoelastic models in composite structures. Nodal displacements and thermal data collected from Digital Image Correlation and an infrared camera, respectively, are first interpolated to a mutual background mesh using a Radial Basis Function (RBF). Optimal shape parameters for minimizing the interpolation errors for both datasets are first obtained using the Leave One Out Cross Validation (LOOCV) method, followed by the implementation of a fast regularized forward center selection scheme to reduce the number of displacement data points for interpolation. Full-field displacements are converted into in-plane strains using finite differences. The resulting strain field is used as input to three analytical thermoelastic models (Resin-Rich Layer, Bulk and Homogeneous). Semi-empirical Halpin-Tsai and mechanics of materials-based micromechanical relations for Young's Modulus, Poisson ratios, density and coefficient of thermal expansion are introduced to account for the variability of volume fractions in the predicted thermoelastic response. Other thermo-mechanical properties of the composite material are treated as random variables with a normal distribution. Analytical solutions to the point-wise comparison between the thermoelastic response calculated for each model and measured with the infrared camera are obtained using the Lagrange Multiplier Method. The proposed concept is validated on carbon fiber/epoxy tensile coupons with four different stacking sequences subjected to in-plane tensile loading conditions. The proposed methodology is demonstrated to help circumvent inaccuracies of the conventional thermoelastic model identification process and improve the reliability of strain measuring capabilities in future TSA of composite materials.


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abst. 2231
**Room 3**
Tuesday
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## In-situ detection of aging effects in hybrid specimens using resonant inspection techniques - Part II: Correlating variation of frequency spectra with changes in the specimen


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