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Quantitative Verification of Thin-Film PVDF Transducer Array Performance up to 60 °C

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Thin-film PVDF (polyvinylidene fluoride) transducers are appealing as light weight, durable, and flexible sensors for structural health monitoring applications in aircraft structures. However, due to the relatively low Curie temperature of PVDF, there are concerns that its performance will drop below unacceptable levels during high temperature conditions.

To verify acceptable performance in these environmental operating conditions (EOC), temperature history data was collected in which tests were carried out between 23-60 °C. For these tests, the PVDF sensor was tested along with a PZT (lead zirconate titanate) wafer sensor as a benchmark. The damage feature is the decrease in peak amplitude from the presence of a through-hole defect. The waveguide for the tests was a 1 mm thick aluminum plate and the measurement was completed using the pitch-catch method. The performance of each sensor was evaluated using Receiver Operating Characteristic (ROC) curves and the relative quality of the sensors to detect the defect was evaluated by calculating the Area Under the Curve (AUC) of the ROC curves.

These ROCs can require a significant amount of time and resources to produce, but it is possible to use baseline signals at various EOCs to construct synthetic datasets, which reduce the time and resources required. This was attempted and the resulting ROCs were compared to ROCs constructed using actual datasets at the specific EOCs. The comparison of the two ROCs and their respective AUCs were completed to evaluate the effectiveness of this data synthesis approach for future use with this inspection methodology.