Influence of the Measurement System on the Nondestructive Pyroelectric Evaluation of Embedded Piezoelectric Transducers

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Integrated piezoelectric sensors and actuators enable smart structures with a wide application field like active vibration control or condition monitoring. Usually, the transducers are embedded into components. Thus, they are accessible only to electrical characterization. The analysis of the pyroelectric current generated by thermal waves or pulses is a suitable approach for the non-destructive evaluation of the polarization state of embedded piezoelectric transducers [1]. For small applied electric fields, the spontaneous polarization correlates directly with the pyroeletric coefficient.

The pyroelectric response was analyzed by heating with an intensity-modulated laser beam or laser pulses. In the Laser Intensity Modulation Method (LIMM), the frequency spectrum was described successfully by simplified analytical models [2]. The pyroelectric current in time domain was Fourier-transformed and the spectra were divided by the transfer function of the measurement set-up to account for the influence of the amplifier settings [3]. The real parts of the obtained spectra were in agreement with the LIMM spectra as shown in figure 1. Regardless of the made correction, the imaginary parts were largely affected by the current amplifier settings. Additionally, a large capacitive load of the transducer led to a smaller cut-off frequency. Therefore, we have investigated the influence of the current amplifier and filters on the distortion of the pyroelectric current spectrum. The transfer function was determined for different capacitive loads.

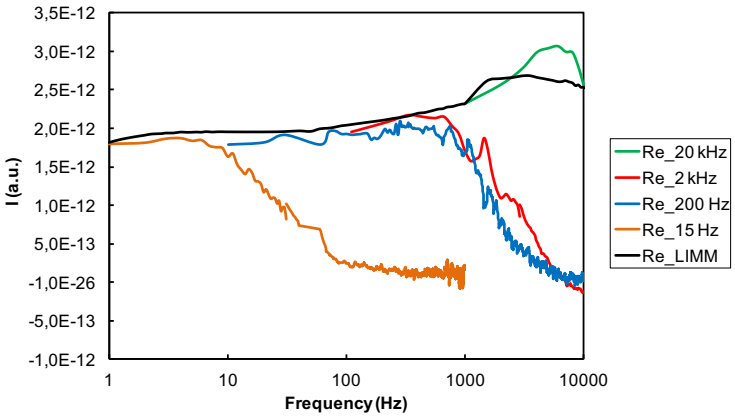

Figure 1: Real parts of the pyroelectric current spectra of a PZT plate for four different bandwidths in comparison to the LIMM spectrum.

Changes of the remnant polarization after fabrication of a structural component demonstrator were determined both by LIMM and thermal pulse measurements of the piezoelectric transducer. The thermal pulse method is much faster, but the obtained pyroelectric current spectra are still noisy and distorted. In future, methods for smoothing the spectra are required. An alternative approach is the analysis of the pyroelectric current in time domain after performing an Inverse Fourier transform.

References

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