

## **POLARIZATION DISTRIBUTION OF THERMALLY POLED PVDF FILMS, MEASURED WITH A HEAT WAVE METHOD (LIMM)**

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The heat wave method LIMM is used to measure polarization distributions of PVDF-films. The PVDF-sample is heated by the absorption of intensity modulated light at the surface of the sample, while the pyroelectric current is measured. The standard LIMM method is extended by the measurement of amplitude and phase of the pyroelectric current. A measuring procedure is given to obtain the current data with a high amplitude and phase precision. It is shown, that the basic LIMM equation is formally inverted by deconvolution, if both amplitude and phase of the pyroelectric current is known. A filtering concept is introduced for the analysis of measured data. The experimental method and the deconvolution procedure is experimentally tested with an antisymmetrically prepared two layer sample (bimorph-foil). The results show, that with LIMM, a resolution of the spatially dependent pyroelectric coefficient in the range of a few microns is possible. Pyroelectricity distributions are reported for thermally poled PVDF-films.

### **1. INTRODUCTION**

Pyroelectric polymers are attractive for low cost piezoelectric and pyroelectric devices.<sup>1,2</sup> A detailed knowledge of the thermal, the piezoelectric and the pyroelectric properties is necessary for the calculation of the sensitivity and the response time of a pyroelectric sensor. Both the piezo- and the pyroelectric activity of the polymer films show a nonuniformity through the thickness of the polymer film.<sup>3</sup> Experimentally observed, unexpected peculiarities in the frequency response of a pyroelectric PVDF detector are attributed to the polarization nonuniformity,<sup>4</sup> thus raising the question how to measure this distribution. For the determination of the piezoelectricity profile the pressure pulse<sup>5</sup> and the pressure step method<sup>6</sup> were developed. These methods give direct images of the piezoelectricity distribution<sup>6</sup> or of its gradient.<sup>5</sup> An experimental comparison of the various pressure wave methods is reported in Reference 7. For the measurement of the pyroelectricity profile the heat pulse<sup>8</sup> and the heat wave method (LIMM: Laser Intensity Modulation Method)<sup>9</sup> were developed. The data obtained from heat pulse or LIMM experiments must be deconvolved to reconstruct the pyroelectricity distribution.<sup>8,9</sup> Recently, a new deconvolution technique for the analysis of LIMM data was introduced.<sup>10</sup>

In the following article a short review of the LIMM method is given with special emphasis on data analysis. An experimental test using a sample, with an a priori known distribution of polarization shows the resolution and the limitations of the LIMM method. Resulting polarization distributions of thermally poled PVDF samples are shown, which are in qualitative agreement with reported piezoelectricity profiles of thermally poled films.<sup>11,12</sup>