Visualization of dynamic stress conditions in elastic solids utilizing high-frequency stroboscopic LED arrays

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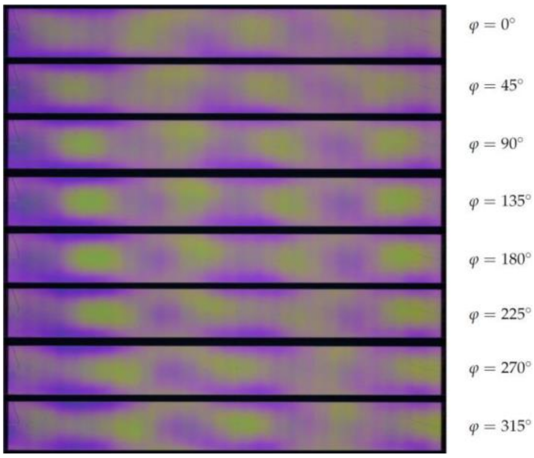
Project ID: B10

The classical method of photoelasticity allows the visualization of stresses in materials showing optically anisotropic behavior under mechanical loads. These include materials such as epoxy resin, acrylic glass and polycarbonate. So far, this method has been used with great success to study static stress distributions. Utilizing recent high-power LEDs in the photoelasticity allows to capture dynamic stresses by high frequency stroboscopic light. Thus, for example, high frequency stationary and transient oscillation processes in elastic solids can be visualized as shown in the picture. Unlike many other techniques the method of photoelasticity allows the direct detection of the stress distribution inside the measured object.



Photoelasticity pictures of propagating ultrasonic waves in a polycarbonate beam at different phase angles.

The temporal and spatial resolution of stress-optic systems depends mainly on the dynamic properties of the lighting technology used. As part of this PhD thesis a tailor-made, high-frequency LED stroboscopic light system for the photoelastic visualization of highly dynamic load conditions in solids shall be developed and studied experimentally. For this purpose, a multi-colored high-power LED array has to be built that consists of several superimposed monochromatic LED arrays of different wavelengths. A separate control of the different colors or wavelengths enables a color-coded parallel operation. In the subsequent image acquisition the light components are filtered according to their wavelengths and thus are separated again. The parallelization of the stroboscopic light sources results in a higher temporal resolution of the photoelastic analyses. This should enable the photoelastic investigation of highly dynamic load conditions (such as stationary and transient vibrations and contact processes), as e.g. specifically used in novel vibration drives and vibratory feeders.

This is a PhD-project of Tailored Light. Tailored Light is a coordinated PhD-programme of the Hanover Centre for Optical Technologies from the Leibniz Universität Hannover together with the Hochschule Hannover, the Laser Zentrum Hannover, the HAWK Hildesheim/ Holzminden/ Göttingen, the TU Braunschweig and the TU Clausthal.

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