New options for finding defects on and below the surface using structured laser thermography

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In infrared thermography, the transient temperature distribution is used, for example, to non-destructively detect defects caused by the externally applied heat flow interacting with the internal geometry of the sample or with inhomogeneities enclosed within it. An equivalent way of describing this interacting heat flow is the propagation of thermal waves inside the sample. Although thermography is suitable for a wide range of inhomogeneities and materials, the fundamental limitation is the diffuse nature of thermal waves and the need to measure their effect radiometrically at the sample surface only. The crucial difference between diffuse thermal waves and propagating waves, as they occur e.g., in ultrasound, is the rapid degradation of spatial resolution with increasing defect depth. This degradation usually limits the applicability of thermography for finding small defects on or below the surface.

A promising approach to improve the spatial resolution and thus the detection sensitivity and reconstruction quality of the thermographic technique lies in the shaping of these diffuse thermal wave fields using structured laser thermography. Some examples are:

- Narrow crack-like defects below the surface can be detected with high sensitivity by superimposing several interfering thermal wave fields,
- Closely adjacent defects can be separated by multiple measurements with varying heating structures,
- Defects at different depths can be distinguished by an optimized temporal shaping of the thermal excitation function,
- Narrow cracks on the surface can be found by robotic scanning with focused laser spots.

We present the latest results of this technology obtained with high-power laser systems and modern numerical methods.

References

[1] https://www.bam.de/thermography