New methods of thermographic super resolution with structured laser heating

Julien Lecompagnon[1], Samim Ahmadi[1], Philipp Hirsch[1], Christian Rupprecht[2], Mathias Ziegler[1]

[1]Non-Destructive Testing, Bundesanstalt für Materialforschung und –prüfung (BAM), Germany,
[1]Beschichtungstechnik, Technische Universität Berlin (TUB), Germany

Thermographic NDT is based on the interaction of thermal waves with inhomogeneities. The propagation of thermal waves from the heat source to the inhomogeneity and to the detection surface according to the thermal diffusion equation leads to the fact that two closely spaced defects can be incorrectly detected as one defect in the measured thermogram. In order to break this spatial resolution limit (super resolution), the combination of spatially structured heating and numerical methods of compressed sensing can be used. The improvement of the spatial resolution for defect detection then depends in the classical sense directly on the number of measurements. Current practical implementations of this super resolution detection still suffer from long measurement times, since not only the achievable resolution depends on performing multiple measurements, but due to the use of single spot laser sources or laser arrays with low pixel count, also the scanning process itself is quite slow. With the application of most recent high-power digital micromirror device (DMD) based laser projector technology this issue can now be overcome. Our studies deal with the application of fully 2D-structured DMD-based excitation and subsequent super resolution based defect reconstruction. We analyze the influence of different testing parameters, like the number of measurements or the white content of the excitation pattern. Furthermore, we have dealt with the choice of parameters in the reconstruction that have an influence on the underlying minimization problem in terms of compressed sensing. Finally, the results of the super resolution reconstruction are compared with the results based on conventional thermographic testing methods.