Numerical study of laser line thermography for crack detection at high temperature

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Abstract

The detection of cracks before the failure is highly significant when it comes to safety-relevant structures. Crack detection in metallic samples at high surface temperature is one of the challenging situation in manufacturing industries. Laser thermography has already proved its detection capability of surface cracks in metallic samples at room temperature. In this work a continuous wave (CW) laser use to generate a laser, which is using to scan the metal surface with notch. The corresponding heat distribution on the surface monitored using infrared thermal (IR) camera. A simplified 3D model for laser thermography is developed and validated with experimental results. A dedicated image processing algorithm developed to improve the detectability of the cracks. To understand the dependency of surface temperature, laser power, laser scanning speed etc. in defect detection, we carried out parametric studies with our validated model. Here we report the capability of laser thermography in crack detection at elevated temperature.

Keywords: Thermal contrast, Laser Thermography, FEM, Elevated temperature, Surface cracks

1. Work details

The commercial Finite Element (FE) package was used for the numerical modelling of heat transfer phenomena during a laser line heating. The model was developed using rectangular block of steel having a 100*mm* length, 100*mm* width and 40*mm* thickness. The objective of this work is to develop numerical models which can address the effect of a laser line heating on a sample. When the defect introduced in the model the heat transfer phenomenon is altered. This phenomenon is handled as an obstruction for the heat flow in the numerical mode
Influence of parameter on thermal contrast studied.

Fig.1 show the increase in maximum surface temperature with different laser power is shown. Both experimental and modeling results are shown in the plot. Both results are showing compromising results. When the laser power increases, increase in surface temperature is linearly increasing. Temperature dependency on process parameter are studied.

- Thermal contrast is decreasing with increasing surface temperature
- Thermal contrast is increasing with increasing laser power
- Thermal contrast is decreasing with increasing scanning speed
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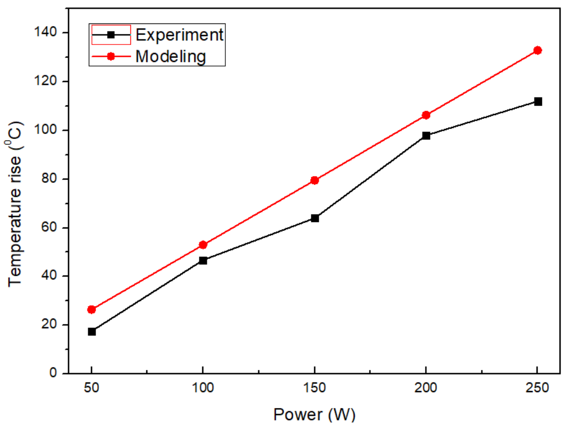

Fig.1 Increase in maximum surface temperature with different laser power

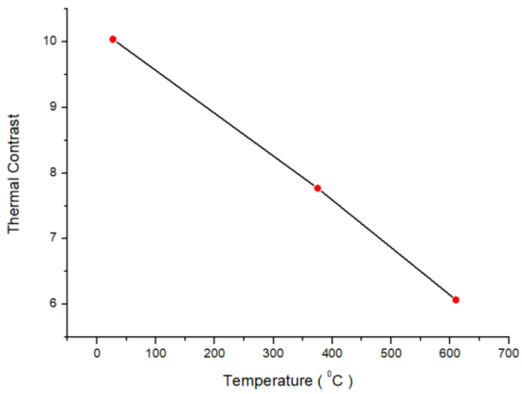

Fig.2 Thermal contrast Vs surface temperature

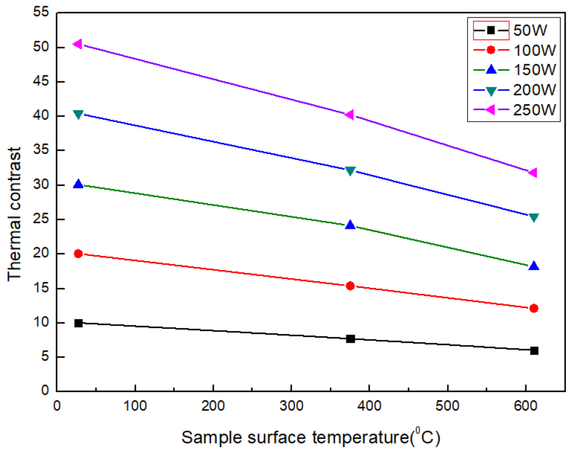

Fig.3 Influence of scanning laser power on thermal contrast

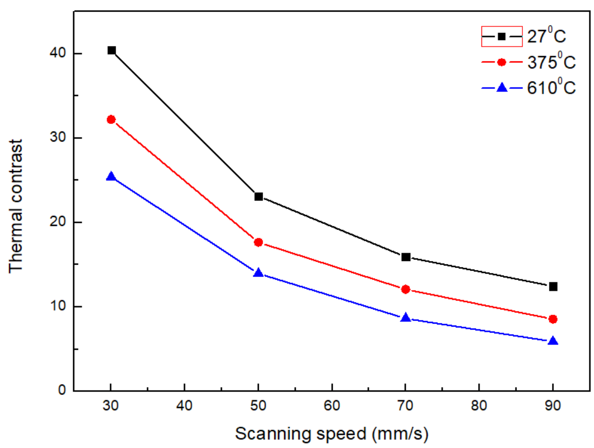

Fig.4 Influence of laser scanning speed on thermal contrast.

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