

Thermography Data Fusion for Failure Analysis

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Abstract

Besides detection of subsurface boundaries it is essential to characterise them and their influence on further development until failure. Thermography is increasingly being applied in the field of non-destructive testing. One reason for this development is that different aspects of defects can be imaged depending on the choice of the excitation source: With optical excitation, heat is deposited in the surface from where thermal waves propagate to be reflected at boundaries. So these images display thermal features. With ultrasound injection, areas with higher losses generate more heat. So the corresponding image displays – at least partially- the imaginary part of Young's modulus which is a mechanical property. So different aspects of the same sample and its defects are displayed with the same thermographic camera. Therefore such images are well suited for data fusion.

The following example has been obtained on a C/C-SiC aerospace material containing an area with a different silicon content. This area is revealed by optically excited Lockin-Thermography (OLT) responding to variations of thermal diffusivity. Ultrasound Lockin-Thermography (ULT) performed on the same sample responds to local conversion of elastic energy into heat which occurs mostly in cracks due to friction effects. Therefore the ULT-image shows selectively cracks while OLT responds to any boundary. The advantages of both methods are combined by data fusion performed here simply by superposition of both images: It becomes evident that the boundary of different silicon contents is the source of crack formation. The reason is in this case different thermal expansion which caused crack initiation at the boundary due to shear load when the sample cooled down after the high temperature production process. So data fusion provides the full information about the defect and how it results in failure.

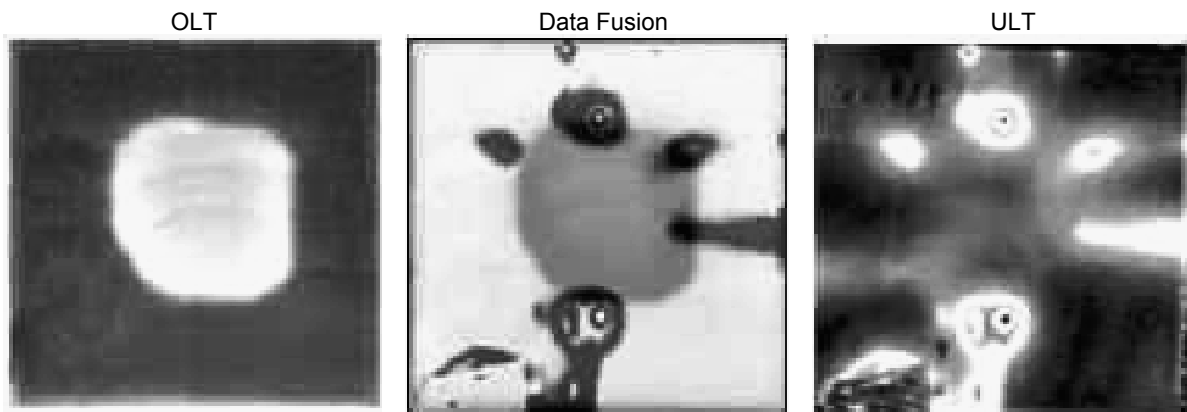


Figure 1: Silicon-carbide (C/C-SiC) block containing an area of different Si infiltration. OLT displays the thermal boundaries and ULT the mechanical losses due to friction heating.

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