

Edge Illumination X-Ray Phase Contrast Imaging for Imaging defects in Composite Structures

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We present a new X-ray imaging technique enabling a detailed detection and identification of defects in composite plates as a result of impact damage. X-ray phase contrast imaging (XPCi) is a new imaging technique relying on the phase effects which occur due to the introduction of an object into the beam. Edge Illumination (EI) XPCi is a differential phase imaging technique, which uses a coded aperture system in order to measure the refraction angle accompanying the phase changes in the beam to create a variation in detected intensity. EI XPCi also allows for the simultaneous acquisition and retrieval of absorption, refraction and dark images, with the latter being a representation of ultra-small-angle scattering from features in the sub-pixel scale. This imaging technique can be implemented with conventional X-ray equipment (rotating anode source, digital detector), and is robust against vibrations and thermal variations.

An example of this application is presented using a 16-ply cross-ply carbon-fibre composite plate which suffered from severe impact damage. The refraction and dark field images complement the conventional absorption images by providing further details on the nature and extent of the damage. The dark field images show micro-damage that is not visible in conventional radiography, such as micro-cracks, fibre damage and inhomogeneities surrounding the main defects. The plate and the damage were also characterised using ultrasonic immersion C-scan imaging for comparison. Further investigation of the technique's damage detection capabilities will be discussed, and X-ray Laminography will also be introduced to investigate a potential use in industry.