Non-destructive assessment of curved carbon fibre-reinforced composite submitted to thermal-shock cycles and impact damage

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Composite materials have been employed at a high rate in several fields like aerospace, naval, military, wind energy industry, petrochemical industry due to their excellent specific mechanical properties, and demand for this class of advanced material is predicted to increase still further. In the space environment, structures are constantly threatened by impact and thermal-shock damages. To ensure continued integrity of composite structures, periodical non-destructive inspection must be used to assess damage severity. In this paper, infrared thermography, a widely employed non-destructive testing technique, is used to inspect curved carbon fibre-reinforced thermoplastic laminate composite specimens subjected to thermal shocks cycles followed by low-energy ballistic impact and assess the material response. Specimens were prepared to mimic typical thermal-shock cycles and impact conditions experienced by geostationary satellites. Pulsed thermography followed by principal component thermography processing was compared to x-ray computed tomography projections to find and characterize typical composite laminate impact damages, notably delamination. It has been shown that infrared thermography is a powerful tool to detect and outline surface and sub-surface damage on curved composite laminates. Likewise x-ray computed tomography, thermography was able to correlate the number of thermal-shock cycles previously applied to the specimen and to the degree of subsequent impact damage.