Structural health monitoring of adhesively bonded joint using optical fibres: applications and perspectives

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The adoption of adhesively bonded structures for aerospace applications is currently limited to secondary structures, while bonding of primary structures still requires the concurrent use of mechanical joints, which limits the potential of adhesives to fully achieve lightweight design solutions. The development of reliable and efficient structural health monitoring techniques may contribute to the acceptance of adhesively bonded primary structures and their certification.
Fibre optics-based solutions for strain sensing have great potential for structural health monitoring of bonded joints. Either discrete strain sensing by Fibre Bragg Gratings (FBG) or distributed sensing by Optical Backscatter Reflectometry (OBR) can be applied to monitor strains either in the bondline or in the adherends. Optical fibres do not significantly alter the properties of the substrates they are inserted in or attached to, the strain sensing technique is free from electromagnetic interference and the amount of wiring and connectors is considerably reduced with respect to other sensors, thanks to the possibility of engraving multiple FBG sensors on a single optical fibre or using the entire fibre as a sensing unit.
In this article, a personal account on the experience gained on the use of fiber optics-based strain sensing solutions for bonded joints and a review of the literature on the existing solutions and application of optical fibres for structural health monitoring of bonded joints is presented, with special emphasis on fatigue crack propagation. The potentials and the limitations of the existing solutions are discussed, with a comparison with other monitoring and inspection methods.