NDT of dissimilar joints using ultrasonic and X-ray CT methods

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ABSTRACT

There is a high demand for lightweight structures for transport applications worldwide. To achieve this "hybrid" structures where introduced where two or more lightweight materials are joined together resulting in high performance lightweight structures. However, for inspection of such structures novel nondestructive testing techniques are required as well.

The objective of this work was to develop novel ultrasonic testing techniques for inspection of several types of dissimilar joints (metal/metal and metal/composite), made from different materials and having different geometries.

Dissimilar metal joints, for which NDE methodology had to be developed, were manufactured using nanoparticles fillers as reinforcing materials (SiC, TiC and CNTs). The lightweight aluminum alloys AA 6082 T6 and AA 5083 H111 were selected as parent materials to be welded with friction stir welding. The incorporation of nanoparticles fillers as reinforcing materials presented a challenge to the NDE methodology to be implemented. The conventional NDE techniques used for inspection of welds were not suitable. It was determined, that for inspection of dissimilar metal joints high frequency ultrasonic focused transducers are required. Investigations show, that higher frequency (50 MHz) investigations using scanning acoustic microscopy give detailed view of inner structure of the welds and defects in it. Results, obtained using scanning acoustic microscopy have been validated by 3D X-ray computed tomography (CT). A correlation between the results using both techniques has been established.

The NDE methodology had to be developed also for metal composite joints made from steel/composite, aluminum/composite and prefabricated titanium/composite. Metal/composite joints produced from different metals to fiber reinforced composites presented the great challenge to the NDE technique to be implemented, as different acoustic impedances, propagation velocities and levels of the attenuation of the joined materials in combination with complex geometries and rough surface of the samples complicate the inspection. Several samples with dissimilar metal composite joints with and without defects were investigated using high frequency focused ultrasonic transducers. A special post processing method for extraction of information of the adhesion area was proposed and tested on experimental data. It is demonstrated, that the proposed method removes the influence caused by surface unevenness and positions of the defects in joints can be determined.

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