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Assessment of friction stir weld integrity for process control

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This presentation reports on the development of innovative inspection methods for the evaluation of typical defects in friction stir welds (FSW). The main defects related to material conditions or welding parameters are lack of penetration, worm holes and kissing bonds (vertical) in butt joints, and hooking, worm holes and kissing bonds (horizontal) in lap and T joints. Kissing bonds originate from the remnants of trapped oxide layers and are known as the most challenging problem for inspection of FSW joints. Ultrasonic immersion or laser-ultrasonics combined with the synthetic aperture focusing technique (SAFT) is investigated. Laser-ultrasonics uses lasers for the generation and detection of ultrasound and is therefore non-contact, ultimately for joint quality assessment during welding. Another promising method is pulsed eddy current (PEC) technique, which induces electrical currents in conductive parts, while measuring the direction and magnitude of the resulting magnetic fields as an indication of material condition. Various FSW lap and butt joints for aerospace applications are examined, including dissimilar metal welds. Very good performances are achieved with the two methods for lack of penetration in butt joints, the limit of detectability coinciding with the conditions of reduced mechanical properties. Also, discontinuities such as wormholes, hooking and voids in lap joints are clearly detected using SAFT. The detection of kissing bonds seems to be possible in lap joints using high frequency laser-ultrasonics.

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