Structural Health Monitoring (SHM) for continuous monitoring of hydrogen pressure vessels

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Kurzfassung

While hydrogen is one of the most promising energy carriers, the safety of hydrogen storage technology remains one of the most important factors for technological and societal approval. While the engineering safety factors of the pressure vessels are kept high, the periodic inspection and the limited lifetime are making the application very costly considering manpower, time, money, and material waste. The development of an integrated structural health monitoring system can allow an easy transition from the current situation to cost-effective predictive maintenance. Hence, we propose to integrate three different SHM systems into hydrogen pressure vessels, namely guided wave ultrasonics, acoustic emission, and fibre optic sensing, to continuously monitor the condition and integrity.

In this work, we evaluated the condition of a Type IV composite overwrapped pressure vessel using ultrasonic guided wave propagation. We mounted fifteen piezo-electric wafers on the composite cylinder by shaping three rings containing five sensors each. We acquired data from the sensor network following different boundary conditions with artificial damages on the selected locations. The data were evaluated with guided wave tomography techniques using ultrasonic features (amplitude, frequency, etc.) as well as artificial intelligence (AI). The results suggest that both traditional guided wave fusion techniques and AI-based characterization methods can detect artificial damages. In future work, it is planned to integrate acoustic emission and fibre optic sensing. Moreover, the measurement and the test results will be implemented into a digital twin to derive trends and make predictions on the damage propagation as well as the remaining useful lifetime.

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