

FDP-41

NONDESTRUCTIVE INSPECTION USING HTS-SQUID ON ALUMINUM LINER COVERED BY CFRP

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A fuel cell vehicle (FCV) alleviates environmental impact. Most FCVs use high-pressure vessels to store gaseous hydrogen on board. Since safety margin of the vessel is measured only by destructive testing, a large amount of extra margin is required to ensure the safety at present time. Thus, nondestructive inspection (NDI) technique to ensure the safety of the vessel in operation has been strongly demanded. However, conventional NDI techniques have not successfully detected deep-lying defects in the vessel composed of aluminum liner covered by CFRP. Since HTS-SQUID has uncontested magnetic sensitivity even in low frequency range, we developed eddy current-based SQUID-NDI system for multi-layer composite-Al vessels. In the NDI system, HTS-SQUID gradiometer was mounted in a cryocooler. As an inducer, two double-D coils with ferrite cores were employed and aligned on both sides of SQUID. An ellipsoidal dome-shaped Al liner overwrapped with CFRP containing through crack in Al liner was prepared. Thickness of the vessel was 6 mm (CFRP 3 mm, and Al 3 mm). The crack parallel to vessel axis was made by pressure cycle test. The shortest distance between SQUID and vessel was 5 mm. While inducing eddy currents in the vessel by excitation fields at 100 Hz or 7 kHz, the vessel was rotated under the SQUID. The SQUID measured field gradient radiated from eddy currents. Above the crack, anomalous signals were clearly observed at both frequencies. These results suggested the SQUID-NDI technique would be a possible candidate for inspection of multi-layer composite-Al vessels.