In situ and real time corrosion damage monitoring by Lamb waves: application to aeronautic structures

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Corrosion poses a serious threat to industry, particularly in the aerospace sector. There are currently no in situ means of detecting the onset of corrosion of a material in service. Regular visual inspection procedures are still the most effective, but the resolution of the human eye is not high, and some areas of industrial plants can be very difficult to access. We describe here a Lamb wave-based method for detecting the onset of corrosion damage and for quantifying in situ and in real time its size so as to replace visual inspections. This work is part of the COQTEL project funded by the French National Research Agency. The material studied is a 316L stainless steel widely used in industry. A localized corrosion pit is generated in a controlled manner in the center of a test specimen through the use of a microcapillary which inject extremely locally a corrosive solution. The corrosion state is followed electrochemically in real time by recording the applied potential along with the resulting current and this allows to estimate the corroded volume. Furthermore, the corrosion damage is also visually monitored in real time using an optical microscope. The acoustic response obtained using Lamb wave techniques generated by piezoelectric elements (PZT) positioned on the specimen and crossing the corrosion damage are also measured in real time along with the other measurements. Obtained results demonstrate that a corrosion damage as small as 100 µm can be monitored in real time both visually and through the classical electrochemical approach. In addition, Lamb waves signals are post-processed to compute damage indexes and it is demonstrated that those damage indexes correlate adequately with damage size measured visually or estimated electrochemically. Lamb waves thus appear as an efficient mean to monitor corrosion damages from their initiation in situ and in real time.