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Microdamage detection and monitoring using nonlinear elastic wave spectroscopy over a wide frequency range

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Innovative diagnostic techniques based on Nonlinear Elastic Wave Spectroscopy (NEWS) have been implemented for global inspection of microdamage in intact and damaged aeronautical components using low and high frequency sound waves. For low frequency analysis, we focused on the amplitude dependent analysis of the resonance behavior, both in time and frequency domain. Alternatively, we have analyzed the time-windowed interaction of a hammer impact with a high frequency continuous wave. The results of both techniques agree extremely well, and prove their potential for quick and global microdamage detection. For local inspection, we have implemented a combination of the traditional elastic wave time reversal technique with a phase coded pulse sequence selective excitation. Alternatively, sparse array tomographic reconstruction with NEWS pre-treatment could be used. The nonlinearity based imaging techniques are illustrated on aeronautical components, and discussed in terms of the feasibility and usefulness of the methodologies as new tools for microdamage imaging.