Simulation of the Propagation Character of the Ultrasonic Wave under Electromagnetic Loading

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Due to the influence of stress, tension, impact and cyclic load in the process of manufacturing and processing, the metal structure are inevitably to generate fatigue crack or other tiny damages in the component. If without timely detection, these tiny defects will expand, merge and form the macroscopic crack, eventually inducing failure of the component. The detection of micro-crack in the metal components is a very important section. Traditional ultrasonic testing achieved detection based on the linear feature of the defect, such as reflection, scattering and signals in the process of ultrasonic propagation. When the crack width is less than a half of the ultrasonic wavelength, the reflection will be very weak and it is invalid for the traditional ultrasonic technique. Nonlinear ultrasonic nondestructive testing is based on the nonlinear character which is generated by the interaction between the crack and ultrasonic wave. However as a new nondestructive testing technology, the application of nonlinear ultrasound in the detection of micro defects also has some limits like the complex loading equipment. In order to acquire the effective detection of micro cracks, a composite detection method is proposed. By using the continuous sinusoidal pulse current as excitation and loading the bias magnetic field and high frequency eddy current at the micro crack, the Lorenz force will make the crack in a state of fluctuation which will impact the propagation process of the ultrasonic.

In this paper, by simulating the nonlinear response process, the modulation effect of the ultrasonic wave because of the fluctuation of the micro crack can be realized and the micro crack will be detected. The signals will be analyzed in time and frequency domain and the components of ultrasonic modulation will be extracted to identify the closed crack effectively.

Acknowledgement:

This work was supported by National Natural Science Foundation of China (51077036, 51207105, 51307043) and Natural Science Foundation of Hebei Province (E2016202260).

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