ABSTRACT

The primary aim of this investigation is to identify suitable nondestructive evaluation (NDE) parameters to unambiguously characterize microstructure and mechanical properties developed up on aging (isothermal: 755 K/ 0.25-100 h, and isochronal: 605-905 K, 3 h) of solution annealed (1093 K, 1h) M250 grade maraging steel. The influence of complex microstructural changes e.g. annihilation of dislocations and quenched-in vacancies, precipitation of two intermetallics and austenite reversion that occur during aging of maraging steel and their influence on the mechanical properties and different estimated NDE parameters have been assessed in order to search correlations between these parameters. The sensitivity and the ability of the NDE parameters obtained from different NDE measurements like ultrasonic, magnetic, eddy current and positron annihilation have been analyzed.

The ultrasonic shear and longitudinal velocities are found to be sensitive to intermetallic precipitation and austenite reversion respectively, whereas Poisson's ratio is found to be sensitive to both precipitation and austenite reversion. The magnetic Barkhausen emission (MBE) RMS voltage is found sensitive to the formation of reverted austenite. Information about precipitation as well as formation of reverted austenite could be revealed by the magnitude and phase angle of eddy current (EC); additionally annihilation of defects during initial aging could also be determined by the EC parameters. Confirmatory evidence for defect annihilation during initial aging and defect structure due to precipitation of intermetallics at longer aging duration could be established using positron lifetime measurements.

An attempt has been made to unambiguously determine the austenite-free microstructure with desired precipitates and their corresponding mechanical properties belonging to the heat treatment regime of technological importance (3-10 h, at 755 K) for M250 grade maraging steel. Distinct characterization of this regime has been shown to be possible using either only Poisson's ratio or EC parameter. But NDE parameters like ultrasonic velocity, MBE RMS voltage and positron lifetime is singly found to be limited to characterize this regime. The correlations established between single NDE parameter with mechanical property e.g. "MBE RMS voltage vs. hardness" and "ultrasonic velocity vs. yield strength/impact toughness" can be used to determine the optimized microstructure and mechanical properties of M250 grade maraging steel. The possibility of using multi-NDE parameters to demonstrate this regime of technological importance is also indicated.

Key words: Maraging Steel, Nondestructive Characterization, Microstructure, Mechanical Property, Thermal Aging