Hardness depth assessment of induction hardened steel by a comparative approach using Barkhausen Noise and Ultrasonic signals

J. Holmberg[1, 2]*, P. Hammersberg[3], P. Lundin[4] and J. Olavison[5]

[1]*RISE IVF AB, Argongatan 30 431 53 Mölndal, Sweden*
[2]*University West, ISE IVF AB, Gustavs Melinas gata 2, 461 32 Trollhättan, Sweden*
[3]*Chalmers Technical University AB, 412 96 Göteborg, Sweden*
[4]*Schlumpf Scandinavia AB, Flygfältsgatan 2D 128 30 Skarpnäck*
[5]*Volvo Group Trucks Operations Volvovägen 5 54 187 Skövde, Sweden*
Keywords: Steeel, Induction hardnening, Hardness depth, Barkhausen noise, Ultra-sonic, Statistical analys
*e-mail: jonas.holmberg@ri.se

The major challenge in automotive industry is achievement of necessary material properties of a given component to withstand loads during its use. Critical properties involve correct microstructure and hardening depth which is essential to verify from manufacturing.

Today this is solely done by destructive testing where manufactured parts are sectioned to smaller pieces and the properties is verified relative the operational window of the process. For the case of cam shafts this is necessary every time the production is reset from one article number to another or other planned or un-planned interruptions. The verification process is very costly, since production stands still.

The need for non-destructive alternatives is therefore obvious and prior investigations has shown great potential in both the Barkhausen noise (BN) and Ultrasonic testing (UT) methods [1-2]. Recent research has also advanced the analyzing methodology of the response signal for sub-surface microstructural characterization and case depth measurements by using magnetizing sweep BN method [3].

Barkhausen noise is well-known of its sensitivity to microstructure and UT is also known to be effective for material characterization. One of the major differences between the two technologies has been the analyzing depth of the material to be characterized. Traditional BN is only effective within few tenths of millimeters from the surface. However, magnetizing sweep BN as well as UT has shown to be sensitive to both surface and sub-surface (several millimeters) characteristics of the material depending on the configuration.

The major motive in this investigation has been to compare the two methods and also to investigate if a combination of the two methods could be used for assessment of the hardening depth of induction hardened steels for the depth interval 2-7 mm. This is typical depths that is used for producing induction hardened camshafts within the automotive industry.

In the present investigation cylindrical steel specimens of grade C45 was induction hardened to generate different hardness depths. The heat treatment was performed in an induction hardening equipment by alternating the scanning speed and power. The produced specimens had hardness depth in the interval 2-7 mm and was evaluated by BN and UT measurements followed by destructive verification of the material properties.

The results show great potential for both BN sweep technology and UT to measure the hardening depth down to 4 mm.

Acknowledgments: This work was supported by Vinnova the the Swedish government agency within Ministry of Enterprise. Special thanks to Stresstech Oy, Volvo Group Trucks Operations and Teknoheat AB for support in this research.

[1] S. Sirén."Case depth measuremenst on induction hardened crankshafts by using ultrasonic backscattering metod", Master thesis Uppsala Univeristy, June 2017.
[2] M. Dubois, M. Fiset, "Evaluation of case depth on steel by Barkhasuen noise measurement", Materials Science and Technology, vol. 11, 1995, pp. 264-267.
[3] S. Santa-aho, "Utilization of Barkhausen noise magnetizating sweeps for case-depth detection from hardened steel", NDT & E International, Vol 52, 2012, pp. 95-102.