

Nanoindentation and Its Application on Gear Teeth

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Abstract. The main objective of the paper is to evaluate the hardness of cemented surface layers of gear teeth. In engineering practice, hardness tests provide us with a good mapping of the required surface layer quality. However, information on basic mechanical properties such as elastic modulus is often required, which can be a problem in the case of surface layers. Appropriate experimental techniques have been chosen to address this topic, bearing in mind that these are not bulk materials. Hardness values obtained from microhardness and instrumented hardness measurements were compared. In addition, the experiments carried out on the nanoindenter, i.e. the instrumented hardness tests, provided valuable information on the elastic modulus behaviour in the cemented layer, the results of which were used for computational analyses of the extreme stresses of pinion and gear teeth. The instrumented hardness was measured on a Hysitron nanoindenter using an indenter with Berkovitch geometry, which is a regular triangular needle. By analyzing the lightening part of the nanoindenter load curve, using the Oliver and Pharr method, the values of the so-called instrumented hardness were obtained. For comparison with other hardness tests, a recalculation was performed using the geometric similarity of, for example, the Vickers and Berkovitch indenter, i.e. their identical projection surfaces. The general trend of high hardness values in the cemented layer is evident for both experimental techniques i.e. microhardness and instrumented hardness. Indentation size effect is further addressed in the paper. An invaluable advantage of using nanoindentation over conventional hardness testing is also to obtain another important characteristic i.e. modulus of elasticity and its subsequent use in stress calculations.