Abstract

The topic of this PhD thesis is a surface treatments characterization in spur gears by means of both Active and Passive Thermography. More in detail, surface treatments on C45 gears (induction hardening) and on 20MnCr5 gears (case hardening-carburizing and shoot peening) were studied for two different moduli (3 mm and 4 mm). Nowadays, the surface treatment quality in terms of residual stresses is principally investigated with diffraction methods and, therefore, gears or complex components are destroyed for the analysis. Moreover, the effects of the surface treatment on the mechanical performances of component such as gears are generally investigated with time-consuming tests. In this activity, the potentiality of Thermography was exploited for the surface treatments characterization as an alternative technique with respect to classical methods.

The Active Thermography technique was properly tuned to identify residual stresses generated by surface treatments. Each surface treatment was first accurately studied with dedicated samples, and both residual stresses and thermal diffusivities were also measured with the classical approaches (X-ray diffraction method for residual stresses and Hot Disk for thermal diffusivities). Then, a dedicated Active Thermography setup was developed and a Design Of Experiment approach was performed to identify the optimal experimental parameters. Moreover, the thermal diffusivity was chosen as possible indicator of residual stresses and the Lock-In technique was adopted for the thermal diffusivity estimation by using the "Slope Method".

The Passive Thermography was utilized to investigate its feasibility for the bending fatigue limit characterization in case of spur gears. A detailed mechanical characterization in terms of static and fatigue tests was carried out from samples made of the same gear material. The thermographic approach of the Two Curves Method was utilized for the fatigue limit estimation in case of both samples and gears, allowing advantages of a Non-Destructive technique and measurements rapidity. Moreover, the thermographic approach was also investigated by using different damages evolutions that are available in literature. In order to perform this activity, a special testing equipment for a mechanical pulsator was designed, and gears were tested at the so-called Single Tooth Contact Point by using the Wildhaber approach.