

# Characteristics of Residual Stress Profiles in Hard Turned versus Ground Surfaces with and without a White Layer

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## Abstract

Hard turning and grinding are competitive processes in many cases for manufacturing various mechanical products. Product performance is highly dependent on the process induced residual stresses. However, there exist some inconsistency regarding the true residual stress profiles generated by hard turning and grinding with and without the presence of a white layer. This study aims to clarify the pressing issues via an extensive residual stress measurement for five surface types: hard turned fresh (HTF), hard turned with a white layer (HTWL), ground fresh (GF), ground with a white layer (GWL), and as heat treated. The x-ray diffraction data revealed distinct differences in the residual stress profiles for the five surface types. Specifically, the results have shown that (i) HTF surfaces generate a “hook” shaped residual stress profile characterized by surface compressive residual stress and maximum compressive residual stress in the subsurface, while GF surfaces only generate maximum compressive residual stress at the surface; (ii) HTWL surfaces generate a high tensile stress in the white layer, but has highly compressive residual stress in the deeper subsurface than the HTF surface; (iii) GWL surfaces only shift the residual stress to more tensile but does not affect the basic shape of the profile; (iv) Tensile residual stress in the HTWL surface is higher than that for the GWL one. However, the residual stress for the ground white layer does not become compressive and remains tensile in the subsurface; (v) Elliptical curve fitting is necessary for measuring residual stress for the HTWL surface due to the presence of shear stress induced severe  $\psi$  splitting; (vi) Residual stresses by grinding show more scattering than those by hard turning; and (vii) Machining is the deterministic factor for the resulting residual stress magnitudes and profiles compared with the minor influence of initial residual stress by heat treatment.

*Keywords:* residual stress, hard turning, grinding, white layer

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