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## MATERIALS TESTING FOR PRODUCTION TECHNOLOGY

# Performance of coated and uncoated carbide/cermet cutting tools during turning

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### Article Information

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#### **Keywords**

*Turning operations, carbide/cermet cutting tools, cutting force, surface roughness, artificial neural network*

Historically, cutting force and surface roughness are known to be important performance indicators in conventional machining operations. These are mainly affected by material type and the choice of cutting tool. A well-known method to improve cutting tool performance is coating these tools with durable ceramic coatings to protect them from thermal degradation. This work elucidates the advantage of  $Al_2O_3$  and TiN coatings and presents important performance improvements in turning operation. Process parameters such as cutting speed, feed rate, cutting depth and tip radius were taken into consideration in a total of 540 experiments. The design of the experiment and a statistical analysis were performed to reveal significant process parameters. An experimental setup was designed to measure in-situ cutting force and surface roughness of the machined surfaces was measured. An artificial neural network model was developed to predict optimum performance parameters.

In conventional machining operations cutting forces and surface roughness are known to be important performance indicators. These are mainly affected by material type and the choice of a cutting tool. Various important machining parameters also affect machining quality. Factors such as surface

and surface roughness were investigated by Kumar et. al. [4]. Roughness, residual stress, and the white layers as parts of surface integrity were classified as functions of the machining parameters and of the integrity of the cutting edge, i. e. of tool wear. Determination of the best suitable cutting conditions and

this work indicate that when machining 4340 steel using low feed rates and low cutting speed, the forces were higher for harder steel and that the surface roughness of the machined part was improved. Cutting speed was elevated and determined the best feed rate [6]. Neural network

roughness and dimensional accuracy. Several open-literature works emphasize this overlooked area. However many important machining parameter effects have not been adequately quantified. Work by Chen et al. studied optimal grey-fuzzy controller design for a constant turning force system. They explored the control of the turning process at a constant cutting force under various cutting conditions utilising the Taguchi experiment design approach [1]. Another research work concerns the influence of feed rate, cutting speed, and tool wear on the defects induced by turning on case-hardened 27MnCr5 gear conebrakes with an emphasis on its technical limitations in mass production [2]. This work also offers a mathematical model predicting the forces opposing the processing parameters [3]. The performance of ceramic cutting tools against tool wear, cutting force

cutting parameters during machining of AISI 304 stainless steel was studied by taking the process sound into consideration [5]. The ideal cutting parameters and the cutting process sounds obtained are compared and the best cutting parameters depending on the process sound are given. The machinability of hardened AISI 4340 high strength low alloy steel and AISI D2 cold work tool steel was studied by Lima et. al. [6]. The tests involving the AISI 4340 steel were performed using two hardness values: 42 and 48 HRC; in the former, a coated carbide insert was used as a cutting tool, whereas in the latter a polycrystalline cubic boron nitride insert was employed. The machining tests on the AISI D2 steel hardened to 58 HRC were conducted using a mixed alumina-cutting tool. Machining forces, surface roughness, tool life and wear mechanisms were assessed. Results in

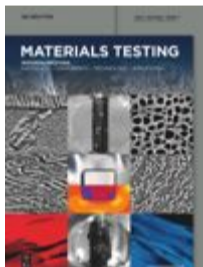
predict surface roughness and wear over the machining time for cutting conditions in finish has also carried out with regression developed to capture process parameters [7]. The wear mechanism of tools made of tungsten-carbide, polycrystalline cubic boron nitride, polycrystalline diamond (PCD) investigated in another study using and temperature results available literature [8]. For the tool/work pairs WC/steel and PCBN/hardened steel practical conditions, tool wear can be greatly influenced by temperature. The authors conclude that the most dominant tool wear mechanism for steel and for PCBN is chemical wear. More experimental results and further research is required to determine

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