

## An Investigation of Machining Performance for Controlled Surface Quality Requirements in Porous Tungsten

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Tungsten is a material with highly resilient thermal and mechanical properties, which is desirable in a wide range of industrial applications. Tungsten in porous form is crucial for the manufacture of dispenser cathodes. The porosity (pore size and pore distribution) is a key controlling parameter in the dispenser cathodes industry. Most research done on porous tungsten has been focused on the processes in which the base material is produced. The customer driven need for documenting and ensuring characteristics of the material such as density and consistency have prioritized this research. This research establishes criteria for the refinement and repeatability of the production processes, such as sintering conditions and powder particle properties, to produce this specific microstructure. However, there is insufficient documentation of the current industrial practices available for machining processes to produce the finished dispenser cathode surface using CNC machining operations. The emitting surface of the dispenser cathode is generated by a manual turning operation process. Even with highly specialized skilled machinist undertaking the burdens of producing acceptable parts the scrap rate is still extremely high. This can become very expensive very quickly due to high material costs. During this process, the surface of the porous material is often smeared by the cutting tool and the pores are collapsed (Figure 1).

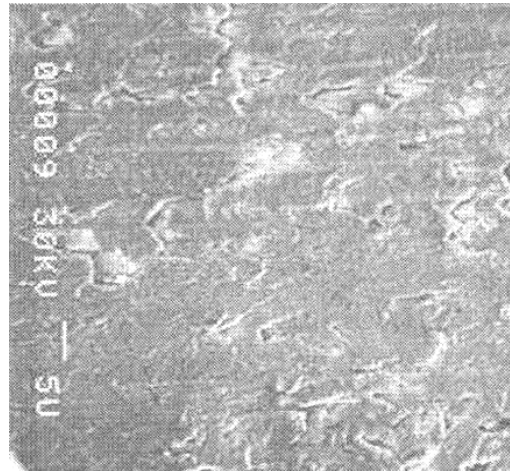


Figure 1: Unacceptable Smeared surface -SEM picture (Carbide tool, C-7)

The proposed work in this paper will concentrate on modeling and optimization of face-contour turning of porous tungsten for controlled surface quality requirements. A study of the combined effects of workpiece geometry, work material properties, tool geometry (i.e., cutting edge radius, nose radius, rake angle, inclination angle, etc.), tool material properties (carbide and diamond tool inserts), and machining conditions (cutting speed, depth of cut, and feed) on the porosity in face-contour turning of porous tungsten was undertaken. There are many analyzable characteristics of the cutting phenomenon that can be determined from the output of the system. The empirical data needed for developing accurate modeling equations can be acquired from this output criteria. The cutting edge radius of the tool insert can be measured before and after the machining process with a white light interferometer to determine the initial patterns of wear on the cutting edge. The chips being removed will be gathered and classified. The forces applied to the workpiece will be measured with a multi axis Fischer dynamometer to determine the resultant and component forces at the insert to material interface (Figure 2).

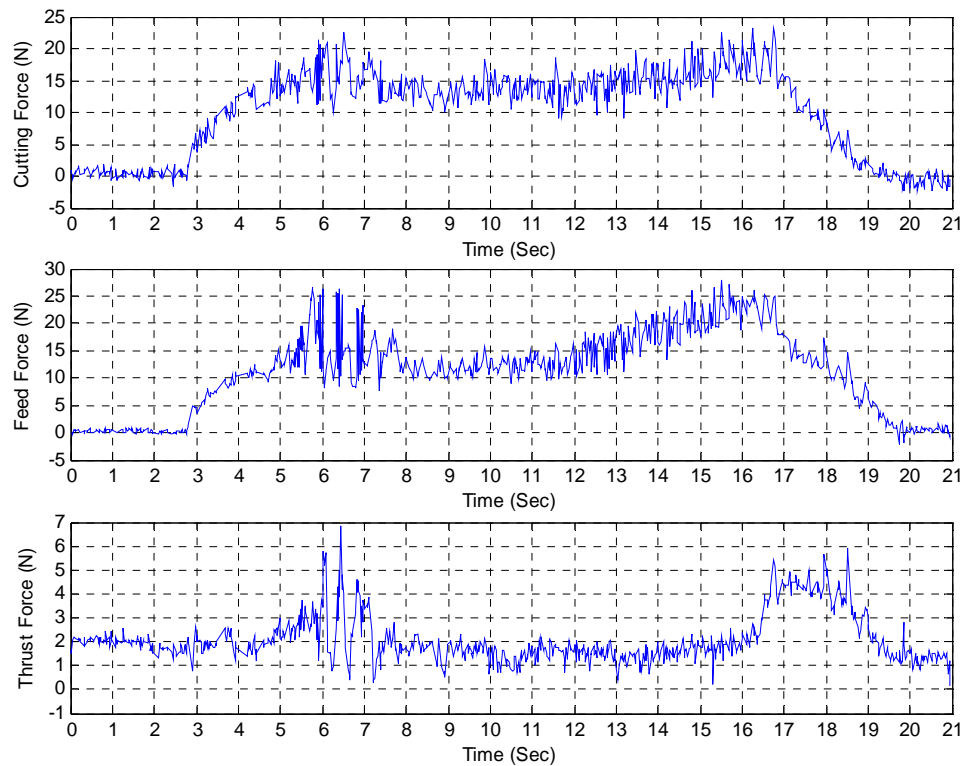


Figure 2: Cutting force Measurement ( Sandvik diamond tool N 151.4-800-60-AL)

There are many factors that need to be taken into consideration when modeling a cutting phenomena but there are also many tool at our disposal to improve our predictions. Suitable diamond tool inserts with optimized tool geometry and cutting conditions will be recommended to dispenser cathode manufacturers to obtain acceptable emitting surfaces (Figure 3).

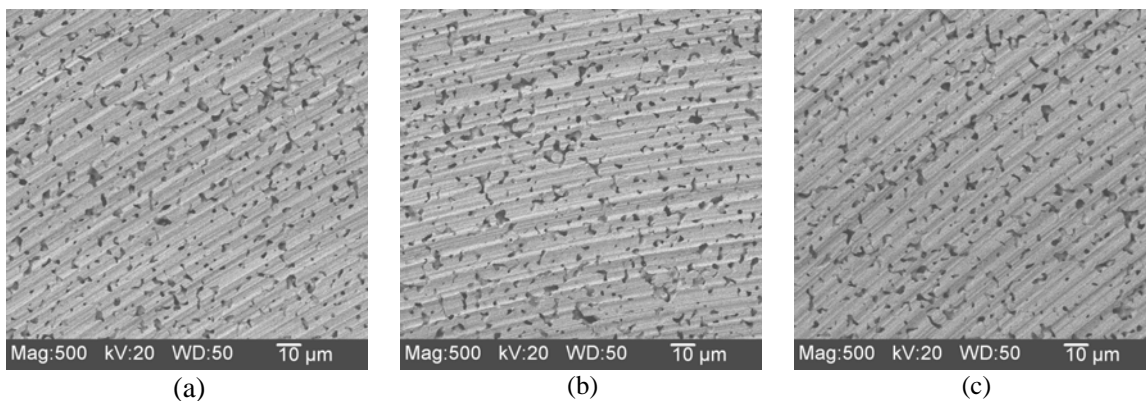


Figure 3: Comparison of porosity distributions in contour turning of porous tungsten with different tool inserts

- (a) Acceptable surface - SEM picture (Using 4 mm Nose radius Diamond Tool Insert, after 5 cuts)
- (b) Acceptable surface - SEM picture (Using 2 mm Nose radius Diamond Tool Insert, after 5 cuts)
- (c) Acceptable surface - SEM picture (Using 2 mm Nose radius Diamond Tool Insert, after 5 cuts)