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Machinability Analysis by Wire Cut Electroerosion of Special Hard Metals

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ABSTRACT

The good succesfull of Hard Metals is to their chemical composition, ich done exceptionally mechanical proprieties. For this reason the HM are used for tools production involve in machined of steel, wood and artificial stone. The paper present a cualitative analysis of HM machinability by wire electroerosion.
Keywords: *electroerosion, machinability, hard metals.*

1. Introduction

Hard Metals have found various applications, mostly in the machining of steel, wood and stone. Their chemical composition varies according to the mechanical and chemical characteristics demanded. For example:

- Turning demands a good resistance to high temperatures, so the Hard Metals has a short metal phase, 6 - 19% Co, and small additions of carbides, like TiC or TaC;
- Forging needs greater resistance and so alloys with more cobalt, 8 - 20% Co, and pure WC.

Therefore, the cobalt, which has provided to be an ideal alloying element to produce Hard Metals with high mechanical properties, gives a law corrosion rate. In aggressive environments where a good corrosion rate is required, steels with a high percentage of alloys are still being use. When there are no particular stresses and much more hardness is desired, Hard Metals alloyed with nickel instead of cobalt are used.

Due to their extreme hardness, it is preferable where possible, to proceed to sintering of bars; because of the high reduction in volume, more then 30 - 40%, that this procedure involves, it is not possible to obtain tools or dies with complex geometry and high precision. In this case the machining of the parts is carried out by means of two processes:

- conventional - grinding;
- nonconventional - electroerosion.

Because the grinding technique involves costly synthetic diamonds and long period of machining, the electroerosion technique provides some advantages, as: favorable production costs, high precision, versatility and degree of automation.

2. Analysis of the phenomena during wire cut electroerosion

The production of complex geometric and high precision tools use the currently technology based on the following steps: one full-side cut and two roughing cuts, with the same power level. In this case the final minimum roughness is Ra = 0,85 µm with a tolerance of T = ± 4µm.

Figure 1 shaw the most important phenomena located during the wire cut process:
- thermal influence, zone I;
- electrolytic dissolution, zone II;
- corrosion on eroded surface, zone III;
- supplementary corrosion (pitting), zone IV.

Zone I - Thermal influence: Is caused by the electrical discharges used to remove the workpiece material and has several negative consequences on the structure of the eroded surface, as: dissolution and removal of the metal phase, separation of the carbides, surface tension, microslots.

This is necessary to reduce thermal influence to a minimum by resorting to successive finishing cuts having law energy; in this manner the zone I, influenced by full-side cut can be completely removed.

Zone II - Electrolytic dissolution: During the electroerosion process a rather intense

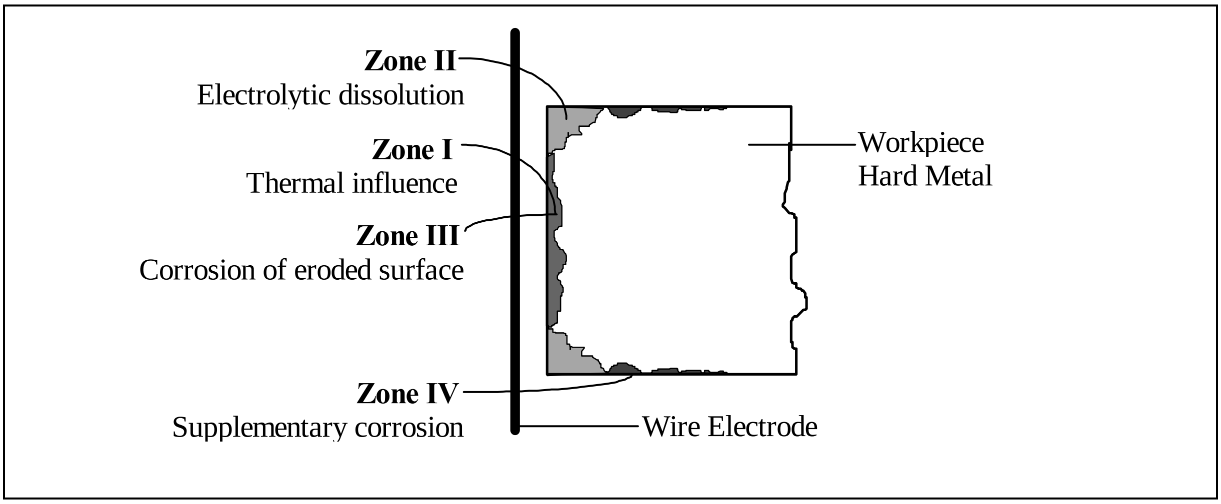


Figure 1. The important phenomena located during the wire cut process

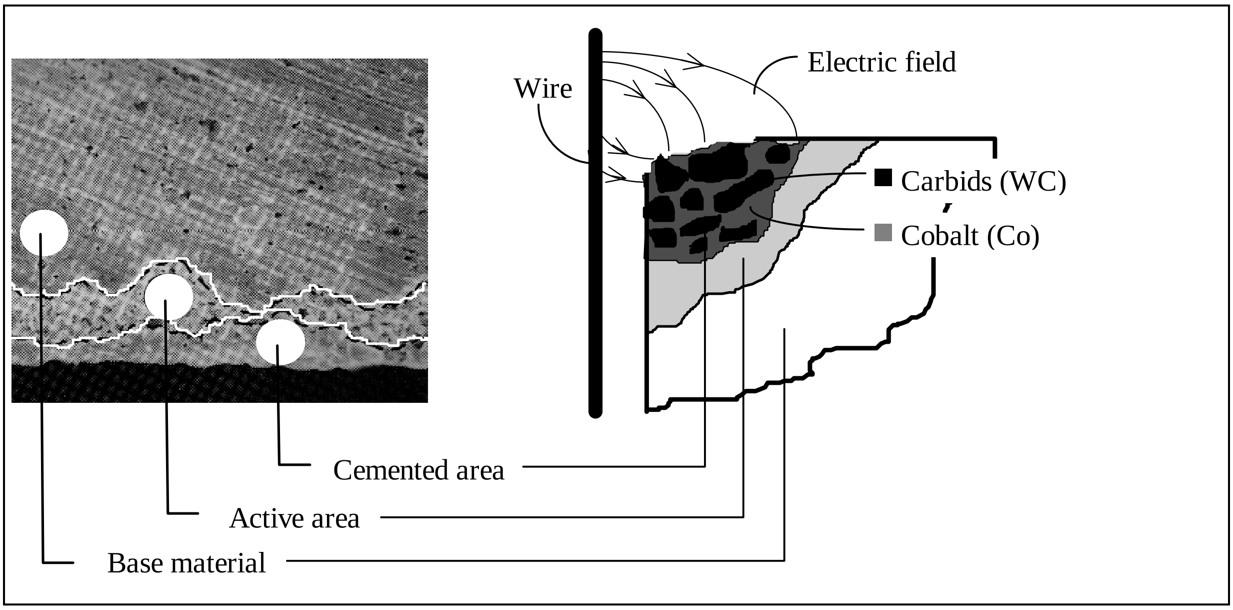


Figure 2. Electrochemical reaction – detail of Zone II

electric field is formed by the active area between the anode - workpiece and cathode - wire, along the edge at the inlet and outlet of the cut-wire (figure 2).

This phenomenon activates an electrochemical reaction that induces a fast and significant loss of cobalt by the Hard Metal. The resulting washed areas represents a dangerous source of slotting and provokes a fast deterioration of the cutting ability of the tool, that is recommended before the tool is utilized, this layer must by removed with maximum depth noticed 10 ÷ 15µm.

Zone III - Corrosion of eroded surface: Frequently an eroded surface shows an aggression of punctiform corrosion which is presence of numerous microholes, or an immediately layer of material.

Zone IV - Supplementary corrosion: We established that the corrosion of Hard Metals takes placed with the typical formation of small holes and for this reason it is called punctiform corrosion, or "pitting".

This phenomenon involves all the surfaces of the bar immersed in the water jet, around the gap. The supplementary corrosion have the consequence of the dissolution of the metal phase with the liberation of cobalt in the dielectric. In practice, these two phenomena cannot be separated by electroerosion process because both are closely linked to the same corrosive processes and must be fought with the same means.

3. Results

The percentage of cobalt present in the Hard Metal has a very important influence on the speed of erosion and the quality of the eroded surface (figure 3). A high content of alloying element decreases the speed of removal and increases a quantity of solidified metal deposits on the eroded surface.

The best surface quality obtained with standard technology on wire cut machines varies between Ra = 0,85 ÷ 1,25µm, and the thermal influence layer is evident (figure 4).

Using a modified electroerosion technique: one full-side cut, two roughing cuts and three finishing cuts with lower energy, can be obtained a very good eroded surfaces, Ra = 0,2 ÷ 0,55µm, without thermal influence layer (figure 5).

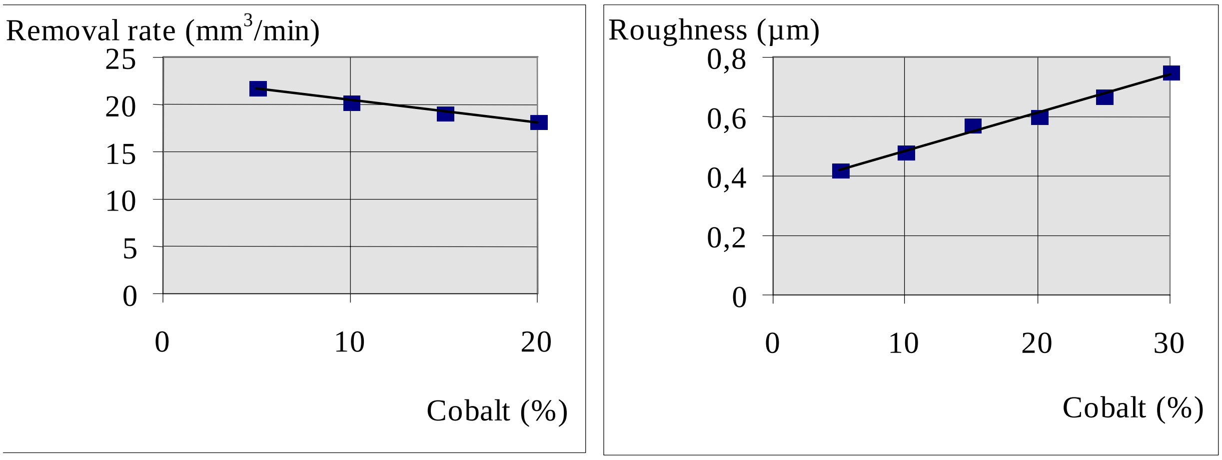


Figure 3. Influence of cobalt on the speed of erosion and the surface quality

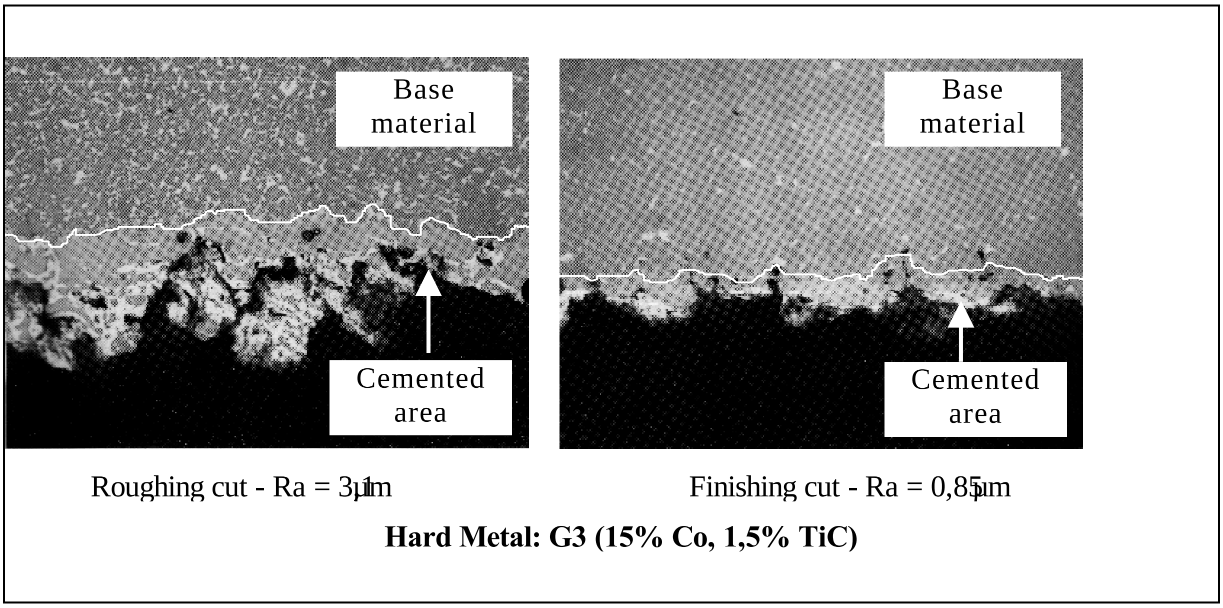
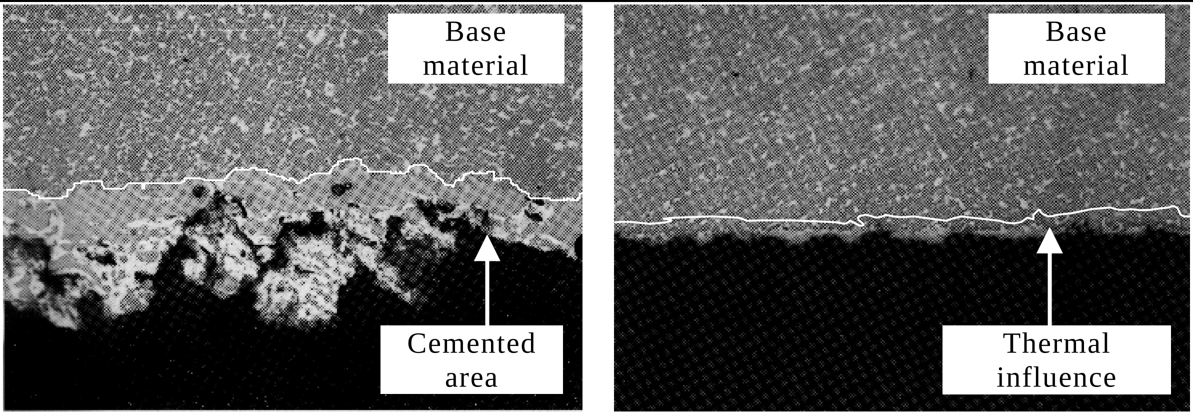


Figure 4. Surface quality – standard electroerosion technology



Roughing cut - Ra = 3,1µm Finishing cut - Ra = 0,3µm

Hard Metal: G1 (6% Co, 0,5% TiC)

Figure 5. Surface quality **-** modified electroerosion technology

4. Conclusions

i. The speed of erosion and the roughness are strong influenced by the percentage of cobalt.
ii. The presence of mixed carbides, with W, Ti, Ta, have not influence on the erosive process.
iii. Another factor that can have an important influence on the corrosive process of Hard Metal, during the electroerosion process, is the conductivity of the water.
iv. The ideal conductivity of water varies from 5 to 10µS/cm, but for the modified erosion technique it is necessary to use dielectric at 1 ÷ 3µS/cm.

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Analiza prelucrabilității prin eroziune electrică cu fir a carburilor metalice speciale

Rezumat

Succesul obținut de carburile metalice este datorat naturii compoziției lor, care le asigură proprietăți mecanice de excepție, fapt care a condus la utilizarea lor pe scară largă la fabricarea sculelor pentru prelucrarea oțelului, lemnului şi pietrei. Lucrarea prezintă o analiză calitativă a prelucrabilității carburilor metalice prin eroziune electrică cu electrod filiform.

Characterisation technologique de l'électroérosion à fil des aliages extradures

Resumé

L'étude presente une annalyse detaillée du processus d'électroérosion à fil appliqué pour l'usinage des outiles speciales utilisées dans l'industrie de: aciers, boi et céramiques. L'analyse est concentré sur les paramèters de la qualité des surfaces erodées.