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Spacing roughness parameters analysis on the EDM of TiB_2

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Abstract

Titanium diboride (TiB_2) is a novel sintered ceramic material which has attracted a great deal of interest because of its excellent mechanical properties, wear resistance and chemical resistance. At present, this ceramic is used in specialized applications in such areas as impact resistant armor, cutting tools, crucibles and wear resistant coatings. In this present research work, effects of current intensity, pulse time and duty cycle on the spacing roughness parameters Sm and Pc have been studied. In addition, statistical tools based on the design of experiments as well as multiple linear regression techniques have been used. Experimental results suggest that the optimal conditions to obtain a minimum Sm of 52.60 µm and a maximum Pc of 190.60 cm^{-1} were: 2 A, 5 µs and 0.4, respectively, for current intensity, pulse time and duty cycle.

Keywords: Roughness; EDM; TiB_2; Manufacturing.

1. Introduction

Titanium diboride (TiB_2) is a sintered ceramic material which has attracted a great deal of interest because of its excellent mechanical properties, wear resistance and chemical resistance [1]. In addition, unlike most ceramics, TiB_2 can be machined by electrical discharge machining (EDM) due to its good thermal and electrical conductivity [2]. At present, this ceramic is used in specialized applications in such areas as impact resistant armor, cutting tools,

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crucibles and wear resistant coatings [3]. In addition, literature reveals that ceramics such as TiB_2 and B_4C and some composites containing nitrides, carbides and borides can be shaped to an ultra-smooth finish [4].

Up to now, not many researchers have studied the machining of such ceramic, so the EDM of TiB_2 is still a field to be investigated. In this line, Malek et al. [5] made an attempt to assess the interrelationships between microstructure, mechanical properties and EDM behavior of B_4C–TiB_2 composites with respectively 30, 40 and 60 vol.% TiB_2. Gaikwad and Jatti [6] tried to optimize EDM process parameter for maximization of material removal rate during machining of NiTi alloy. Rengasamy and Rajkumar [7] used TiB_2 particles to reinforce Aluminum 4032 in order to analyse the influence of both mechanical properties and parameters such as material removal rate and tool wear rate in EDM process.

In this present study, an analysis of surface roughness of an EDM'ed TiB_2 ceramic has been carried out. Concretely, the parameters selected were: Sm (mean spacing of profile irregularities) and Pc (peak count) which can be found in UNE-EN ISO 4287:1999 [8] and UNE-EN ISO 4287:1999/A1: 2010 [9]. Moreover, both parameters have been studied in terms of current intensity supplied by the generator (I), pulse time (t_i) and duty cycle (η). To do that, statistical tools based on the Design Of Experiments (DOE) as well as multiple linear regression techniques have been used. Moreover, the adequacy of the proposed model has been carried out though analysis of variance.

2. Methodology and experimental procedure

In this section the equipment and the materials used to conduct the experimentation are first described. Then, the design of the experimentation is developed.

In the present study, the equipment used to conduct the experiments was a conventional die-sinking EDM machine model ONA DATIC D-2030 S. As a dielectric fluid, mineral oil was chosen as it improves the stability of the EDM process. The part and electrode materials selected were TiB_2 and electrolytic copper, respectively. All the experiments were subjected to positive polarity as it was experimentally proved that a more stable process was obtained.

Once the experiments were carried out, surface roughness parameters were measured with a profile rugosimeter as can be seen in Fig. 1. The values of the cut-off and the evaluation length were 0.8 mm and 4 mm, respectively. Moreover, a Gaussian filter was used.

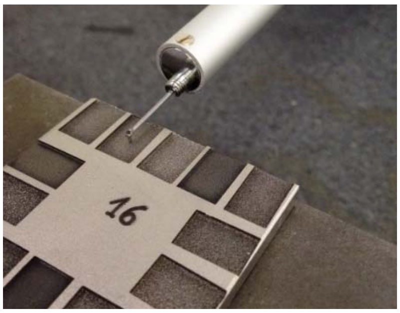

Fig. 1. Measurement of surface roughness.

Also, a factorial design 2^3 with four central points was selected. For the second-order model, six additional star points were used. Table 1 shows the design matrix for the second-order model and the results obtained in the experimentation.