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Study on Electrical Discharge Machining Characteristics of Electrically Conductive Ceramics

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Abstract. This paper deals with EDM characteristics of newly develops electrically conductive ceramics. Titanium boride (TiB_2) is widely used as die and mold materials because of its high hardness, high-temperature resistance and so on. The EDM characteristics of the titanium boride, such as electrode wear rate, removal rate and surface roughness were investigated. Experimental results show that EDM with low electrode wear rate is possible when copper electrode is used with positive polarity. The removal rate becomes much higher when graphite electrode is used with negative polarity.

Introduction

Fine ceramics have many excellent functional properties such as high hardness, high-temperature resistance, corrosion resistance, wear resistance and so on. Therefore, they have been widely applied in various fields including motor vehicle, telecommunication and medical industries. Also in manufacturing of semiconductor and optics, they are used as die and mold materials [1]. Along recent miniaturization of products, a demand for direct machining of the ceramics into small 3-dimensional shapes has increased. However, they are very difficult to machine by traditional mechanical machining method, because of their excellent properties.

Nontraditional machining methods such as laser, ultrasonic, electron beam are partly applied, but the machining of small 3-dimensional shapes is still difficult. On the other hand, many types of electrically conductive ceramics have been recently introduced into the market in order to make it possible to machine the ceramics by electrical discharge machining (EDM). Saito et al. [2,3] reported fundamental EDM characteristics of electrically conductive ceramics such as TiB_2 and SiC. However, electrically conductive ceramics developed recently have more excellent material characteristics, and EDM characteristics of these new ceramics have not yet been made clear sufficiently. Moreover, remarkable progress of recent EDM technology enables the understanding of the EDM characteristics under wide-ranging machining conditions.

The objective of this work is to achieve high efficiency and high accuracy EDM of these electrically conductive fine ceramics. EDM characteristics such as electrode wear rate, removal rate and surface roughness were investigated with varying pulse duration, duty factor, electrode material and electrode polarity.

Experimental Procedures

The experiments are carried out using NC die sinking EDM with transistor switching circuit (Sodick AP1L). Kerosene type working fluid (Sodick hightech VITOL2) was used. Cylindrical copper and graphite of 8mm in diameter were used as electrode. The workpiece material used in this work was titanium boride (TiB_2). TiB_2 is one of the electrically conductive ceramics applied widely as a metal mold material owing to its high hardness and high corrosion resistance.