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On the Surface Roughness of Al-4%Cu/B_4C Metal Matrix Composites Machined by Milling Operation

Mustafa Übeyli[1,*] Adem Acır[2], M. Serdar Karakaş[3], Teyfik Demir[1]

[1]*TOBB Economics and Technology University, Mechanical Engineering*
Söğütözü Caddesi No:43 06560 Ankara - Turkey
E-mail:mubeyli@etu.edu.tr
[2]*Gazi University, Mechanical Education*
06500 Teknikokullar, Ankara - Turkey
[3]*Middle East Technical University, Metallurgical and Materials Engineering*
İnönü Bulvarı 06531 Ankara – Turkey

ABSTRACT

In this study, the influence of cutting speed, feed rate and type of cutting tools on the surface roughness of the boron carbide particle reinforced aluminum composites in the milling operation was investigated. For this purpose, the composite samples were produced using powder metallurgy route. And then, the milling operations were carried out by using three different cutting tools at various feed rates (0.15, 0.20 and 0.25 mm/z) and cutting speeds (100, 130, 169 and 220 m/min). Experimental results showed that the surface roughness of the composites decreased significantly by increasing the cutting speed for all tools. Moreover, it was gradually increased for all tools when the feed rate was increased at the cutting speeds of 169 and 220 m/min.

Keywords: Surface roughness, metal matrix composites, machining, milling.

1. INTRODUCTION

Metal Matrix Composites (MMCs), having high specific stiffness and strength, improved thermal and wear resistance compared to their metallic matrix materials, are classified as one of the advanced material groups. Three main components are available in these materials which are matrix material, reinforcement and interface between matrix and reinforcement. Reinforcements can be used as particulates, whiskers or continuous fibers in the MMCs. The physical and mechanical properties of these components as well as the volume fractions of the matrix and reinforcement materials determine the properties of the MMCs.

Aluminum and its alloys, due to their relatively lower densities, have been used in the MMCs to get high specific stiffness, whereas ceramic reinforcements have been utilized to enhance the thermo-mechanical properties of matrix materials. Particulate metal matrix composites (PMMCs) show higher ductility and lower anisotropy compared to continuous fiber reinforced MMCs. Furthermore, they are much cheaper and can be processed more easily /1/.

Net shaping and good surface finishing of the PMMCs are very important after their production. Therefore, they frequently require to be machined. Nevertheless, PMMCs exhibit poor machinability due to the fact that their hard

* Corresponding author

Furthermore, if the feed rate was increased, surface roughness was gradually increased for the investigated tools at higher cutting speeds. This was considered to be caused by the feed marks /22/. Although the Tool C caused worse surface finish than the other tools at the cutting speeds of 100 and 130 m/min and the feed rates of 0.15 and 0.20 mm/z, the performance of all three cutting tools with respect to surface finish was found to be very similar at higher cutting speeds (169 and 220 m/min). This was most probably due to higher BUE formation on the Tool C and adhesion between the chips removed from the work-piece and the coating material of the Tool C (TiN + TiAlN) compared to other tools. As mentioned before, the BUE formation increases the surface roughness remarkably. At higher cutting speeds, the performance of the investigated tools with respect to surface roughness becomes closer due to the reduction in the BUE formation caused by high temperature between tool and work-piece. In conclusion, the experimental results gained in this study indicated that the cutting speed and feed rate were very effective on the surface finish. The best surface finish could be attainable by using a cutting speed of 220 m/min and a feed rate of 0.15 mm/z with all three tools for the milling of investigated composite.

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