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Machinability of Short Alumina Fiber Reinforced Aluminum Alloy Composites Fabricated by Squeeze Casting

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Extended Abstract

Aluminum alloys are widely used for industrial application because it is lightweight and has a high specific strength and corrosive resistance. However, there is a need to improve the mechanical properties, thermal properties and wear resistance of the alloy. The reinforcement of the alloy with ceramic fibers or whiskers has been proposed as a technique to improve the properties. The alumina fiber would be most suitable for improving the properties of the alloy, because its high temperature strength and hardness are superior. On the other hand, there is a concern about a decrease in machinability of the aluminum alloy by reinforcing with alumina fibers, because alumina is difficult to machine. However, the effects of the fibers on the machinability of the aluminum alloy have not yet been sufficiently clarified. In the present study, two kinds of short alumina fibers having different chemical composition and properties were used as the reinforcements, and a fiber preform was infiltrated with the aluminum alloy melt by squeeze casting in order to fabricate the composite. The fiber volume fraction in the composite was controlled to be 15 vol%. The machinability of the composites was examined with a lathe by cutting the outside surface of the test piece of the composites. Cemented carbide tool was used to machine, and the cutting speed ranged from 50 to 150 m/min.

The fibers were in a random planar arrangement in each composite, and the difference in the distribution of the fibers between 2 composites was not seen. Hardness of the composite B was 130 HV, which was higher than that of the composite A (112 HV), because the fiber B is harder than the fiber A.

Reinforcement with the fibers decreased the cutting force of the alloy for every cutting condition. It is reported that dispersing the hard phases in the aluminum alloy facilitates the shear deformation of the alloy due to the stress concentration in the hard phases during the cutting process (Saga *et al*., 1991). The results that obtained in the present study would be expressed by the same mechanism. The cutting force of composite A was lower than that of composite B. This is probably due to the fact that the hardness of fiber A is lower than that of fiber B. There is no significant difference in cutting force when the cutting speed was changed.

The machined surfaces of the composites were smoother than that of the unreinforced alloy. Although the built-up edge was obviously formed when the unreinforced alloy was machined, it was only slightly formed when the composites were machined. These results reveal that the fibers in the composite suppress the formation of the built-up edge and lead to the decrease in the surface roughness. There is no significant difference in surface roughness between 2 composites.

For every cutting speed, continuous chips were formed after cutting the unreinforced alloy, whereas the sheared or serrated chips were formed after cutting the composites. This result indicates that the fibers in the composite facilitate the shear deformation of the chips because the fibers were easily sheared by the cutting.

References

Saga T., Ikeda S. (1991). Turning machinability of Al_2O_3-SiO_2 short-fiber reinforced ADC12 aluminum alloy composites. J.JILM, 41, 264-269.