Effect of Admix Ratio of Free-machining Agent 'KSX' that Contains Complex Calcium Oxide Powder on Machinability

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Abstract

Free-machining agent 'KSX' contains complex calcium oxide is developed. The effect of admix ratio of KSX on mechanical properties and machinability with two different cutting speeds is reported. KSX displays improved machinability without deterioration of mechanical properties up to 0.3mass% addition. It was observed that KSX is effective with a small addition of 0.1mass% at slower cutting speed, and increased of admix ratio is effective at faster cutting speed.

Keywords : machinability, complex calcium oxide, belag

1. Introduction

To improve machinability of sintered parts, a many kinds of free-machining agents such as manganese sulfide powder (MnS) have been investigated and proposed in the past. *[1] MnS is commonly selected as free-machining agents in steel powder mixtures even though it has some disadvantages such as less effective on machinability at faster cutting speeds and/or harder materials. A new free-machining agent named KSX, that contains complex calcium oxide, has been developed and reported to show superior machinability at faster cutting speeds and/or harder materials without deterioration of mechanical properties. *[2] The effect of admix ratio of KSX on mechanical properties and machinability of sintered part are reported in this paper.

2. Experimental Procedure

Without free-machining agent (No add), with 0.1, 0.2 and 0.3mass% KSX and 0.5mass% MnS based on Fe-2mass%Cupper-0.8mass%Graphite+0.75mass%Lublicant were prepared. Water atomized pure iron powder 300M was selected as base powder. Mean particle size of KSX was 2 μm and MnS was 5 μm. Each mixtures were compacted to a green density of 6.90Mg/m^3, and were sintered in 10 vol%H_2/ 90 vol%N_2 atmosphere for 30minutes at 1393K(1120℃). Hardness, radial crushing strength and tensile strength were measured to evaluate the mechanical properties. The turning machinability test was carried out using cermet tool for 20minutes. Machining conditions were cutting speeds (V) of 150 and 250m/minutes, depth of 0.5mm and feed of 0.1mm/revolution. Frank wear (VB Max), crater wear (Kt) and cutting force were measured to evaluate the machinability.

3. Result and Discussion

3.1 Result

Mechanical properties are shown in Fig. 1. Deterioration of mechanical properties was not observed up to 0.3mass% of KSX addition. Flank and crater wear after 20minutes of machining are shown in Fig. 2 and 3. Flank wear at each cutting speed was reduced with increasing KSX admix ratio. In addition, crater wear at each cutting speed was reduced with increasing admix ratio of KSX. Especially when KSX admix ratio was more than 0.2mass%, the crater wear was not observed. Resultant cutting force is shown in Fig. 4. There was no difference in cutting force after one minute compared with each material. However, as increasing KSX admix ratio, increasing of resultant cutting force after 20minutes was restrained compared to the other materials without KSX. It is considered that this caused restraint of flank wear by adding KSX. As for MnS, improved flank wear was observed compared with No add at 150m/minutes, however, the effect was decreased at 250m/min. Effect on crater wear and cutting force after 20minutes was not confirmed

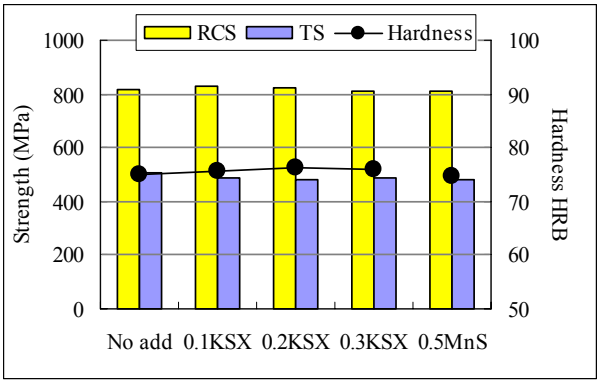

Fig. 1 Mechanical properties

moreover. Tool surface after 20minutes of machining at 250m/minutes was observed by X-ray spectrum, and relative intensity of calcium is shown in Fig. 5. The tendency that X-ray relative intensity increased so that admix ratio of KSX increased was observed. It is considered that this protection layer contains calcium oxide called Belag influences prevention of tool wear by increasing of KSX admix ratio.

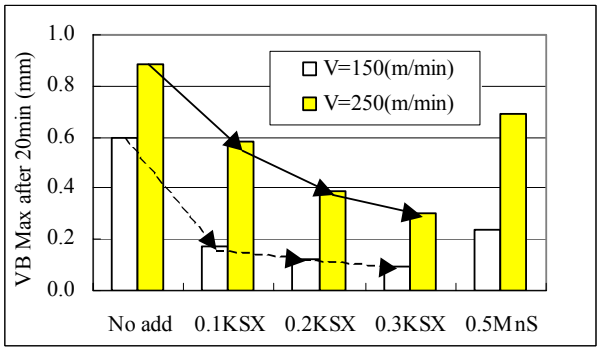

Fig. 2 Flank wear

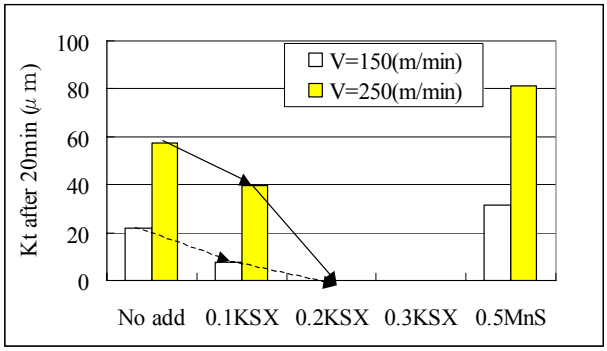

Fig. 3 Crater wear

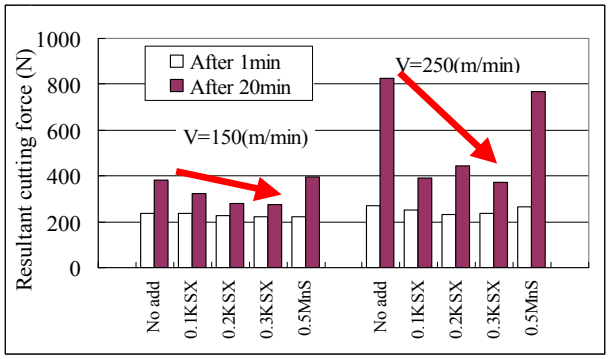

Fig. 4 Cutting force

3.2 Discussion

Mechanism of KSX for the prevention of tool wear is considered as follows,

1) Protection layer (Belag) is formed

KSX softens or melts by frictional heat during machining. It adheres to the tool surface and effects as protection layer. The protection layer prevents tool wear also diffusion of tool element into the chip.

2)KSX has good wetting property

Since titanium oxide performs good wetting property with the oxide including calcium (KSX), it is effective for the formation of protection layer. Titanium element in the tool is stable as titanium carbide. Titanium carbide reacts with iron and/or manganese oxide in the sintered parts during machining, and then oxidized to titanium oxide, which has good wetting property with KSX. The Soften or melted KSX easily adhere to the surface of tool containing titanium carbide.*[3]

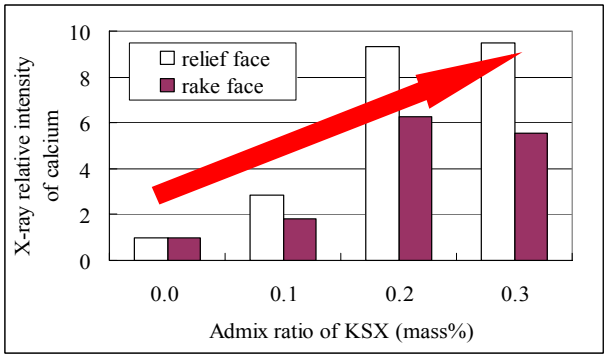

Fig. 5 X-ray relative intensity of calcium on wear

4. Summary

1) KSX improves machinability without deteriorating of mechanical properties up to 0.3mass% addition.
2) KSX is effective on flank wear with a small amount at slower cutting speed, and flank wear is reduced at a rate proportional to KSX admix ratio at faster cutting speed. Increasing of cutting force is also restrained so that frank wear is prevented by generation of Belag.
3) Increasing of KSX admix ratio contributes to restrain of crater wear.

5. References

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