Study on the Effect of Magnetorheological Polishing Speed on Surface Roughness

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Abstract

Polishing powder directly on the surface of the material, its particle size and hardness of the mechanical cutting effect has an important impact. Polishing the harder, the higher the efficiency of polishing, the effect of particle size on the polishing efficiency is more complex. The results show that the higher the particle size is, the higher the polishing efficiency is. In a certain range, the polishing efficiency is proportional to the size of the particle size. However, when the particle size is large enough to a certain extent, the polishing efficiency is reduced, and the particle size should be selected according to the actual situation.

Keywords

Magnetorheological fluid;surface roughness; speed.

1. Introduction

Magnetorheological polishing technology has made considerable progress, and widely used in precision ultra-precision machining, the processing quality, processing efficiency, can effectively remove the sub-surface damage layer[1-3]. Therefore, we should further strengthen the research of magnetorheological polishing mechanism and processing model and the research of magnetorheological fluid, strengthen the research with other processing technology, broaden its processing range, improve its processing quality and processing efficiency, towards a high degree of automation, Flexible, sophisticated, intelligent and integrated direction, making it widely used in optical components processing and mechanical manufacturing processing, as a truly advanced manufacturing technology[4-6].

At present, the common polishing powder is Al2O3, cerium oxide and diamond powder, and its hardness is from large to small diamond powder, cerium oxide, Al2O3, diamond powder for polishing the highest efficiency, but taking into account the diamond powder is expensive, so the choice of cerium oxide As a polishing powder[7-8].

2. Build model

Using cerium oxide as abrasive particles, the silicon surface for the removal of materials, the establishment of the model as shown in Figure 1.

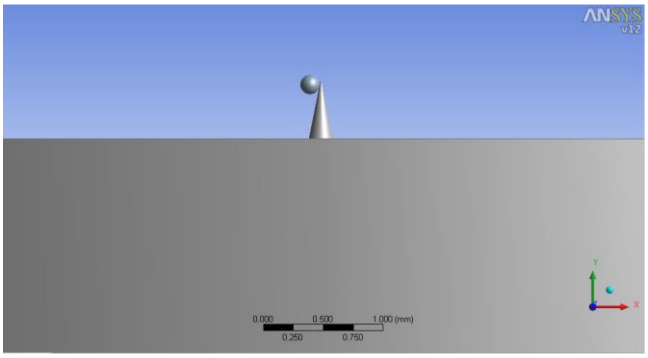

Fig. 1

Among them, the diameter of the ball is 0.16mm, the distance from the silicon plane is 0.45mm, and the radius of the raised surface is 0.1mm, 0.5mm high. The ball is in contact with the protrusion.

3. Add material

Since the workbench does not have the definition of cerium oxide and silicon material, it is necessary to manually add cerium oxide and silicon material properties[9]. By studying the data can be obtained cerium oxide and silicon material density, Young's modulus, Poisson's ratio, specific heat and other properties, as shown in Figure 2, Figure 3 shows. And then need to remove the material surface is defined as silicon material, the nature of the material for the flexibility; the abrasive grain is defined as cerium oxide material, the material properties for the ruggedness, as shown in Figure 4, Figure 5 shows.

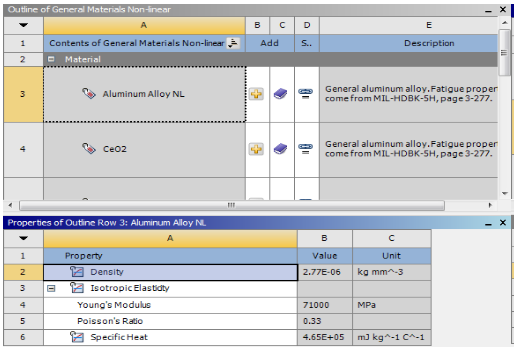

Fig. 2

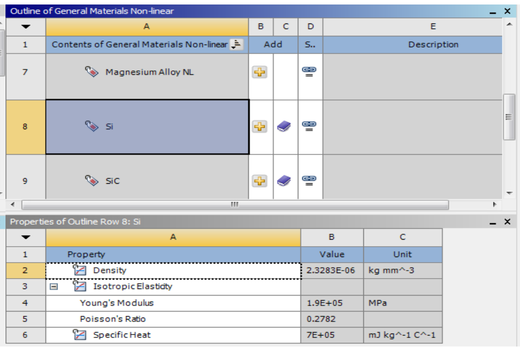

Fig.3

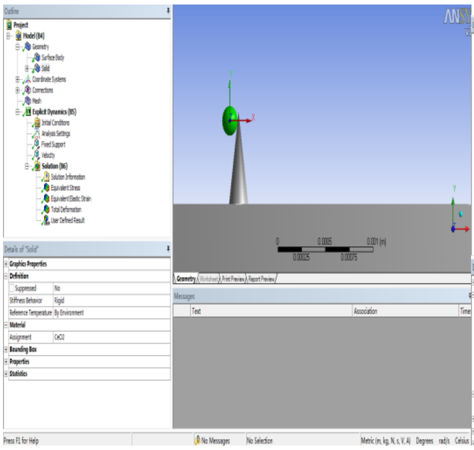

Fig. 4

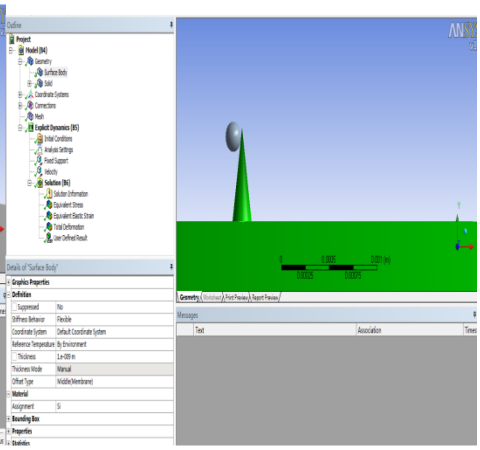

Fig. 5

4. Meshing

To show the dynamic analysis of the material surface removal mechanism, so the intelligent grid can be divided, as shown in Figure 6.

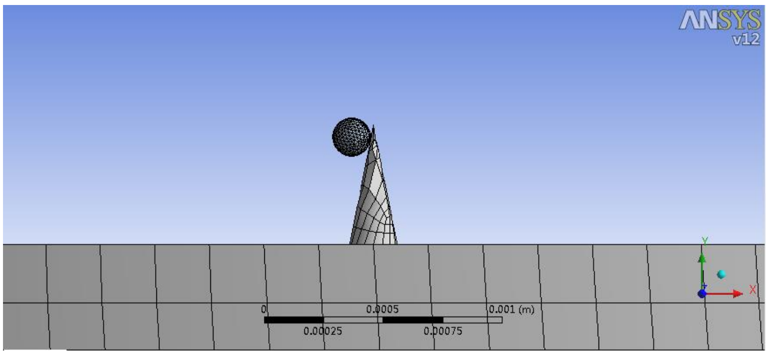

Fig. 6

5. Add a constraint

Since the effect of abrasive grain velocity on material removal was studied, three different velocities were set for the study. In the process of material removal, the cerium oxide particles are subjected to three forces, namely: 1, the pressure, from the surrounding carbonyl iron powder particles in the magnetic field in the magnetic field of the force and fluid dynamic pressure[10]. 2, shear force, from the magnetorheological fluid power. 3, resistance, from the abrasive and the workpiece surface contact, friction. Therefore, given a constraint surface of silicon, as shown in Figure 7, given a certain level of cerium oxide abrasive particle velocity and vertical velocity, tanα≈0.1667, as shown in Figure 8 (a), figure 8 (b), (c) shown in figure 8.

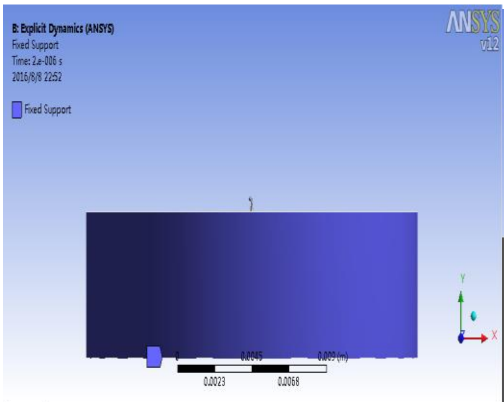

Fig.7

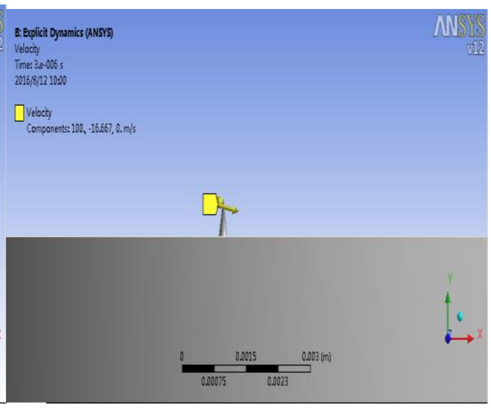

Fig. 8(a)

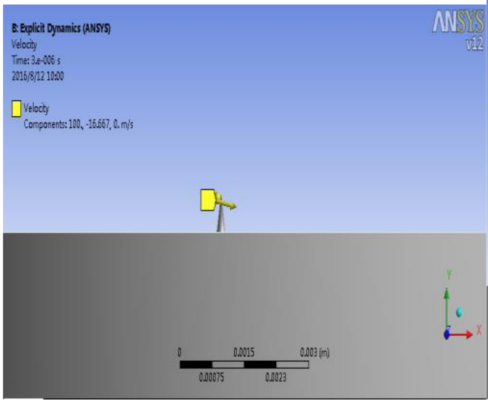

Fig.8(b)

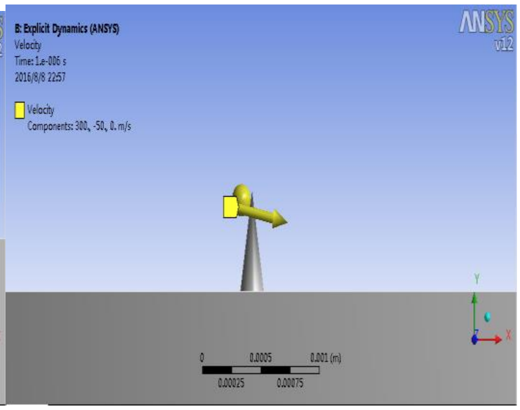

Fig.8(c)

6. Solving and concluding

By assigning different speeds to the cerium oxide abrasive grains, different equivalent stress changes are obtained, as shown in Fig. 10 (a), Fig. 10 (b) and Fig. 10 (c).

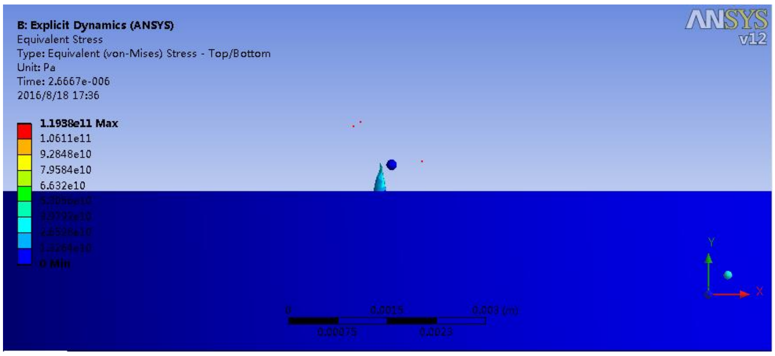

Fig. 10(a)

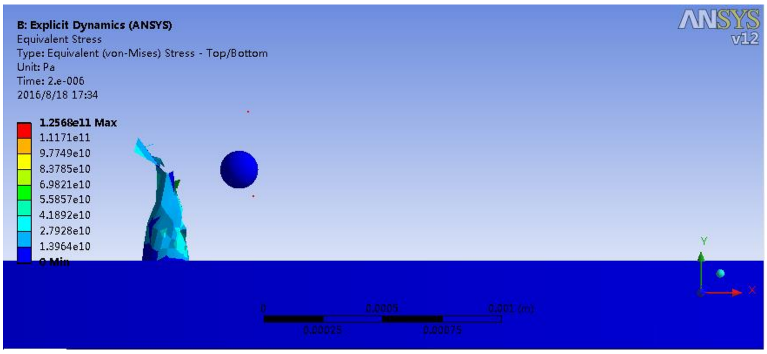

Fig. 10(b)

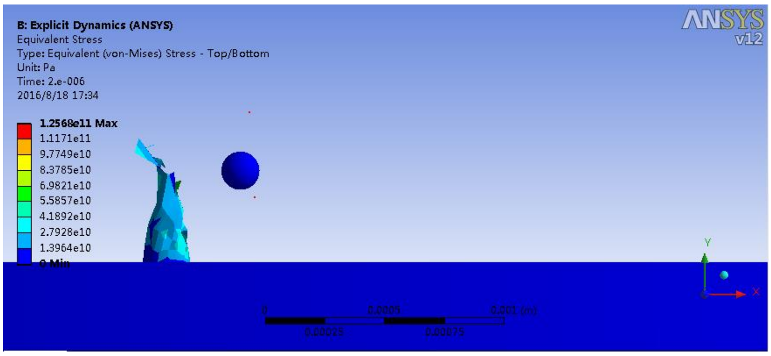

Fig. 10(c)

The data in Table 1.1 can be obtained from the above figure.

Table 1

speed（m/s）		(MPa)	time（s）
X	Y		
100	-16.667	119380	2.6667×10^{-6}
200	-33.333	125680	2.0×10^{-6}
300	-50	129260	1.5555×10^{-6}

It can be seen that the stress removal of the material gradually increases with the increase of the velocity in the process of cerium oxide removal of the silicon surface, and the surface roughness is reduced, and it can be seen that the removal efficiency is proportional to the speed relationship.

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