Measurement of Cohesion Force between Diamond and Matrix in CMP Pad Conditioner

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Abstract

Currently Chemical Mechanical Planarization (CMP) has become an essential step in the overall semiconductor wafer fabrication technology. Especially the CMP pad conditioner, one of the diamond tools, is required to have strong diamond cohesion. Strong cohesion between diamond and metal matrix prevents macro scratch on the wafer during CMP Process. Typically the diamond tool has been manufactured by sintered, brazed and electro-plated methods. In this paper, some results will be reported of cohesion between diamond and metal matrix of the diamond tools prepared by three different manufacturing methods. The cohesion force of brazed diamond tool is found stronger than the others. This cohesion force is increased in reverse proportion to the contact area of diamond and metal matrix. The brazed diamond tool has a strong chemical combination of the interlayer composed of Cr in metal matrix and C in diamond, which enhance the interfacial cohesion strength between diamonds and metal matrix.

Keywords : Diamond tool, Brazing, Cohesion, CMP pad conditioner

1. Introduction

CMP (Chemical Mechanical Planarization) for the polising process of oxide and metal thin film on wafer is the major process among all semiconductor processes. If the CMP pad conditioner is not used in CMP process, residual products will generate a fouling phenomenon on the polyurethane pad as time goes on. Diamond pad conditioner is used to solve this problem by regenerating the pad.

The conditioner plays an important role to keep the pad's initial condition. If diamond would be pulled out of metal matrix, the pulled diamond will be causative of macro scratch on wafer during CMP process. Consequencely, the yield of a valuable wafer is decreaced.

The purpose of this study is to find out the optimum conditions on the basis of measurement of cohesion strength. The conventional sintered conditioner is composed of diamond and metal powder sintered at about 800℃ and high pressure. Electro-plated conditioner has the Ni film generated at 40~65℃ on diamond and steel core. Brazed conditioner has the Ni film generated at 1000℃ and above on diamond and steel core. We measured the cohesion force when the diamond was pulled off. Also, we measured the cohesion force by varying the contact area of diamonds and metal matrix at brazed conditioner.

2. Experimental Results

CMP pad conditioner samples were manufactured by sintered, electro-plated and brazed methods. Three essential parts of these diamond conditioners are diamond, bond (metal matrix), and steel core. The main element of metal matrix in the brazed and electroplated conditioners is the Ni, whereas the main element of metal matrix in the sintered conditioner is the Co. We used the diamonds with the size of 297-420㎛, and manufactured the cohesion force of all conditioners so that they have the same diamond protrusion ratios of 63%. Also, we varied the protrusion ratio of diamond and metal matrix in the brazed conditioner.

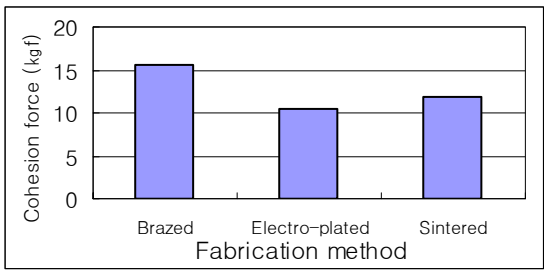
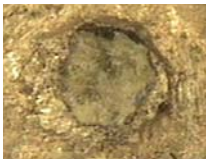


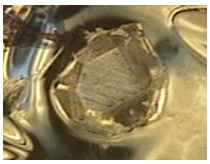
Fig. 1. The diamond cohesion force of CMP pad conditioners manufactured by three different methods.

The result of measurement shows that the brazed conditioner has the highest cohesion strength (Fig. 1). After the diamond is pulled out, the metal matrix of the sintered conditioner and the electroplated conditioner keep the original matrix shape. However, the diamond of the brazed conditioner is breaken and the broken diamond remains the residual part in the matrix. This result was infered the brazed conditioner has a strong cohesion between the interface of the metal matrix and the diamond (Fig 2.).

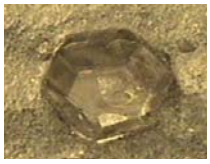
The cohesion strength is also increased in inverse proportion to the protrusion ratios of diamond (Fig 3).



(a) Brazed sample



(b) Electro-plated sample



(c) Sintered sample

Fig. 2. Photo of metal matrix after diamonds are pulled out.

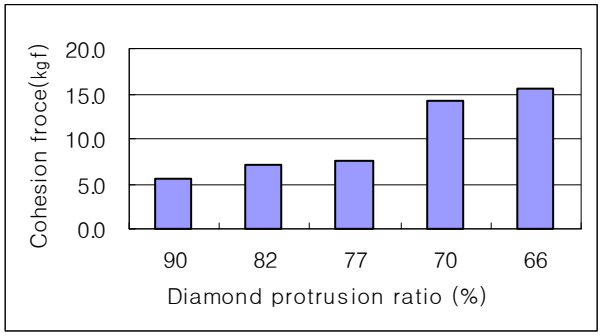


Fig. 3. The diamond cohesion force according to the decrease of protrusion

The EDAX line-scanning analysis shows that the strong cohesion of brazed conditioner is due to the chemical combination of the interlayer composed of the Cr in metal matrix and the C in diamond, which enhance the interfacial cohesion strength between diamond and metal matrix (Fig 4.).

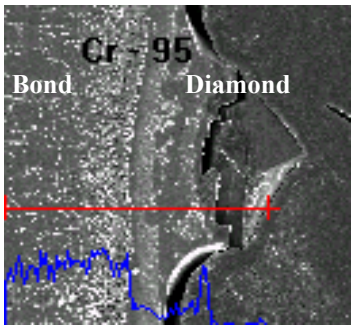


Fig. 4. The EDAX line-scanning analysis of the interlayer between diamond and metal matrix

3. Summary

The CMP pad conditioner manufactured by brazed method has the highest cohesion between diamond and metal matrix because of the carbide-forming alloy element such as Cr, carbide layers are formed on the surface of the diamond that can wet.

4. References

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