23P002-O

Wire Temperature in Removal of Brass Plating on Surface of Saw Wire by Coaxial Magnetron Plasmas

同軸マグネトロンプラズマを用いた
ソーワイヤのブラスめっき除去処理中のワイヤ温度

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DC coaxial magnetron plasma with triangle type electrodes has been developed to remove the brass plating on saw wire. The temperature of fine saw wire has been measured during stripping process. Heating mechanism of saw wire during the stripping process is discussed to keep the wire quality.

1. Introduction

A silicon wafer is produced with the thin slice of the crystal silicon rod by using saw-wire as shown in Fig.1. Brass (Cu: 65%, Zn: 35%) is plated on the surface of saw-wire to make it long. In cutting process of wafer by using the saw-wire, copper atoms diffuses in silicon wafer and the electric conductivity of the wafer changes. Therefore, it is necessary to remove this brass plating. Wet process by strong acid was used as a conventional method for removing the brass plating. However, this method is expensive and cause to negative environmental problems. In the present research, the removal method of brass plating on fine wires is proposed by a dry process using the DC coaxial magnetron plasmas with triangle type electrode.

2. Experimental

The experimental setup of the electrode system is shown in Fig.2. Three electrodes were made of aluminum which set in the equilateral triangle to be a structure to pass the wire through the center of gravity. Negative discharge voltage was applied to the wire to grounded electrodes. DC coaxial

magnetron plasmas were generated by an axially applied magnetic field. As a result, high density plasma could be generated. The gap length between electrodes and the wire was set 10mm, 20mm and 30mm.

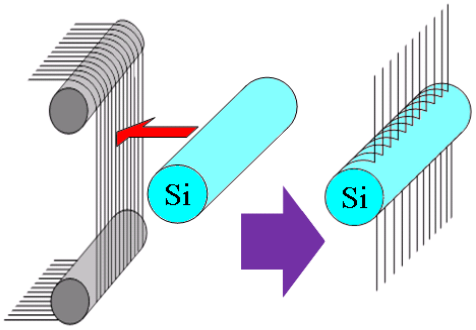

Fig.1 Saw wire

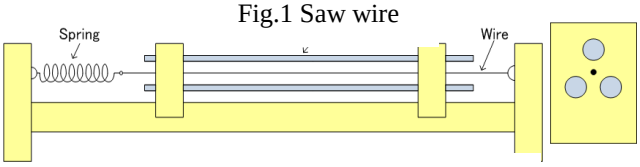

Fig.2 Electrode Structure

3. Results and Discussions

3.1 Stripping Effect

The experimental results of stripping effects were successfully established by using high density magnetron plasma source with 20mm gap in an axially applied magnetic field.

Figure 3 shows the EDS analysis results of wire surface after plasma stripping during 30sec. Here, the discharge voltage was -730V, the constant discharge current density 1.5mA/cm^2 and the discharge gap length 20mm, respectively. In this figure, it is clearly shows that Zn was removed after

10sec stripping and Cu after 30sec. (Fe: 38.5%→97.7% , Cu: 39.3%→2.43% , Zn: 22.2%→ 0.03%)

Let us estimate the required running speed for perfect removal of the brass plating. When the discharge current density was 1.5mA/cm^2, perfect removal could be established after 25sec stripping. Therefore the stripping rate was estimated as 8nm/sec=480nm/min. This means that the required running speed of wire is 4.8m/min for full removal in 2m reactor.

These results suggest that the rapid stripping of fine wire is possible by using the developed triangle type magnetron plasmas. For the higher target voltage and current density to the wire, more rapid stripping can be realized.

If the brass plating removal is assumed to finish at 25sec., the sputter rate can be estimate to be 480nm/min.; here the thickness of the brass plating of the saw wire is 200nm. In this condition, the required winding speed of wire can be estimated to 0.5m/min for completely finishing of brass plating removal in such plasma reactor of 2m in length. The higher discharge current density may be able to realize the faster removal of brass plating on saw wire.

3.2 Wire Temperature

Wire heating during plasma stripping is a serious problem for keeping the wire quality. In this stripping process, before wire heating up to 500℃, perfect removal must be finished. So, high speed but low temperature process is strongly required.

Figure 4 shows the temporal variation of wire temperature measured by the electric resistivity method for the current density 1.5mA/cm^2. When the higher magnetic field, that is, for the constant current density, the higher target voltage leads to the rapid heating of the wire. The heating mechanism seems to be both Joule heating and ion kinetic energy to the wire. So, the optimum condition should be investigated.

4. Conclusions

The removal of brass plating on fine wire has been tried by using newly developed triangle-type magnetron plasma. It was confirmed that sputter etching could decrease the mass percentage of brass on wire surface at the stripping rate of 480nm/min by using sputter etching process. Moreover, the optimization conditions of the removal of brass plating were investigated to make the temperature below 500℃.

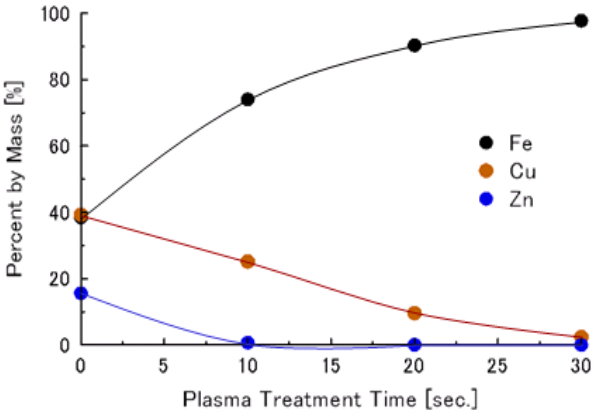

Fig.3 EDS Analysis of Stripped Wire

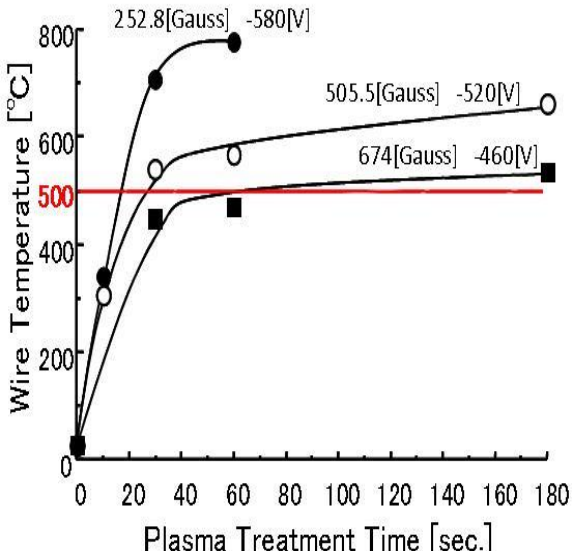

Fig.4 Temporal Variation of Wire Temperature

Acknowledgments

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