Diamond Coating on Extra Fine Wire by Quadrupole Magnetron Plasmas

Takaya Kikai[1]*, Shinichiro Nishiyama[2], Naohisa Iwamoto[2], Yukinobu Tokunaga[2], Masanori Shinohara[1], Hiroshi Fujiyama[1]

[1]*Graduate School of Science and Technology, Nagasaki Univ., Nagasaki 852-8521, Japan*

[2]*Japan Fine Steel Co. Ltd., SanyoOnoda 756-0063, Japan*

Tel: +81-95-819-2542, Fax: +81-95-819-2538, E-mail: plasma@cc.nagasaki-u.ac.jp

Abstract

Trial coating of nano-diamond on fine wire surface has been investigated by using the long-shaped quadrupole cylindrical magnetron plasmas. The results of deposited film quality evaluated by Raman spectra are reported for controlling the wire temperature.

Introduction

This study proposal is upgrade of Saw-wire when it uses for creating silicon-wafer. It is necessary in semi-conduct industry. Saw-wire is that long fine wire that is used for cutting the wafer out from ingot. The wire, itself, does not have the ability of grinding, the wire grind the silicon-wafer by using loose grain which is called slurry. In this study, we attempt to combine the diamond film or grain around the surface of the wire. By using fixed grain grinding, Saw-wire, itself, gain the ability of grinding. This means that the use of slurry will loose its necessity. The diamond Saw-wire, used in the industry, is made by electro coat. The problem is the difficulty of lengthy and its costs.

In this study, we report the result of attempting to coat the surface of the wire by diamond or DLC (Diamond-like Carbon), using quadrupole magnetron plasma which befit for coating lengthy substrate for the purpose of improving Saw-wire.

Experimental

Fig.1 shows quadrupole magnetron plasma generating system. The wire is sat up in the center of four carbon electrode. Four electrodes are located

on a each corner of square, and AC power supply of 60Hz is applied so that

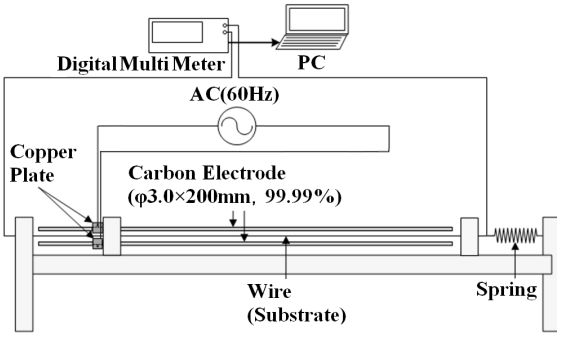

Fig. 1 Quadrupole Magnetron Plasma Generator

the electrode on the opposite corner become equipotent. Here, we tried to estimate the substrate temperature from ohmic value of the wire. Quadrupole system was set in a vacuumed cumber. The solenoid coil was applied excitation current so that the quadrupole magnetron plasma was produced.

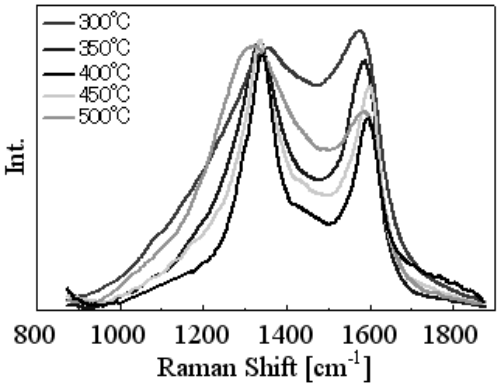

Fig. 2 Raman spectra of film

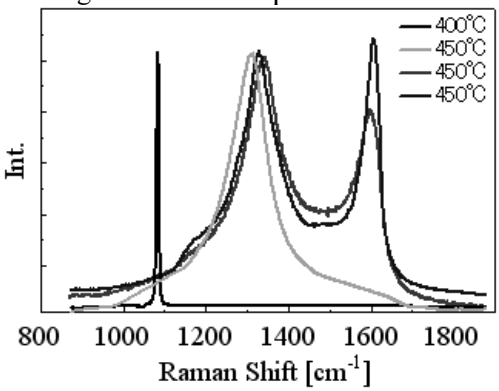

Fig. 3 Raman spectra of grain

Results and Discussions

Figures.2 and 3 show the Raman spectra of film or grain on wire surface in case of changing substrate temperature. The structure sp^3 (shifted 1333 [cm]) is representative example of tetrahedral construction like diamond, and the structure sp^2 (shifted 1600 [cm]) is the planar structure like graphite. In this experiment, for controlling substrate temperature, discharge power was used. Because of increasing discharge power on electrode is the factor of raising substrate temperature. As raising substrate temperature, the plasma gains more density so that it is expected that the more hydrogen radical can be produced and decrease sp^2. However amorphous film was formed when the substrate temperature was 500 degree. It is considered that the effect of surface diffusion or hydrogen detachment. The sharp peak was observed in Fig.3. It looks similar to Raman spectra of diamond. However, its position is far from the peak of diamond to low wave number side. This Raman spectrum needs more observation, but it is considered the peak caused by nano-diamond in present research.

Conclusions

By plasma CVD method with quadrupole magnetron plasma, we attempted to coat diamond on the surface of the wire. The result of the experiment of varying the substrate temperature, raising the substrate temperature can be expected to increase the possibility of synthesizing diamond. However, substrate temperature is getting too high; the result that film turned amorphous. Therefore, it is considered that there are some certain appropriate temperatures. In fact, about synthesizing diamond on the surface of the wire, 400 degree~450 degree on the substrate can be considered appropriate.