Development of CMP method using UV and dissolved oxygen

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1. Introduction

The Chemical mechanical polishing (CMP) is a process that has been used in semiconductor processing for a long time and is the only process that utilizes particles in the semiconductor process [1,2]. The research on CMP process is proceeding in order to remove surface defects and improve material removal efficiency. Particularly, to improve the material removal rate, an electrochemical method or a method of developing a new slurry has been studied. In recent years, various methods for CMP of materials having long processing time such as sapphire, SiC, and GaN have been introduced. Especially, it is known that the CMP method using ultraviolet (UV) rays is easy to install the apparatus and can easily improve the material removal rate (MRR). In addition, studies have shown that the higher the oxygen saturation in the CMP slurry, the easier it is to remove the material.

Therefore, in this study, the CMP apparatus which can increase the oxygen saturation of the slurry and utilize UV at the same time is constructed and its performance is evaluated.

2. UV and dissolved oxygen assisted CMP method

The CMP process utilizes surface chemical reactions between the chemical solution contained in the slurry and the material to be removed. UV irradiation during the CMP process activates chemical reactions by generating hydroxyl free radicals. In particular, when H_2O_2 is included in the slurry, hydroxyl radicals are formed by UV decomposition. This phenomenon can be applied not only to metal CMP but also to CMP of hard materials. The dissolved oxigen content (DOC) of the slurry is also known to affect the MRR in CMP. Therefore, in this study, a nano-micro bubble generator was prepared to increase the DOC of the slurry and a UV irradiation device was installed in the CMP apparatus.

Fig. 1 shows the CMP apparatus using UV and dissolved oxygen prepared for this study. The proposed CMP apparatus is composed of a slurry tank equipped with a nano-micro bubble generator, a CMP apparatus, and a UV irradiation apparatus. A DO meter was used to measure the DOC of the slurry.

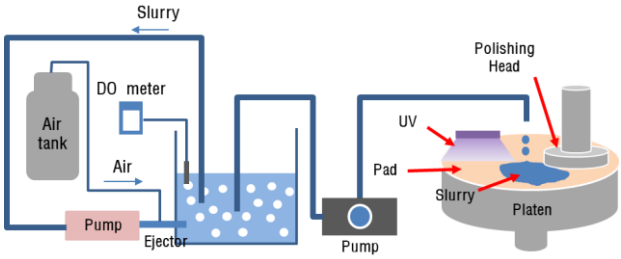

Fig.1 CMP apparatus using UV and dissolved oxygen

3. Experimental conditions

Prior to the CMP experiment, the DOC and pH change characteristics of the slurry were confirmed by using the slurry and DIW. Table 1 shows CMP experimental conditions. A laboratory-made CMP slurry was used, and a polishing pad made of KPX chemical was used as the polishing pad. A Cu plate was used for the experiment.

Table 1 Simulation condition

Rotational speed of platen	87 rpm
Rotational speed of head	103 rpm
Slurry	H_2O_2 base colloidal slurry
Pressure	400 g/cm^2
Slurry flow rate	200 ml/min

4. Results and discussions

DIW was put into the slurry tank and air was injected into the tank. After addition of 3 wt% of H_2O_2 to DIW, DOC and pH changes were measured after air injection. In Fig. 2, as the air pressure increases, the DOC increases rapidly at first but slows after 0.02 MPa, but increases continuously. Overall, when H_2O_2 is added, it shows a somewhat higher DOC. The pH tends to increase as the oxygen supply increases, but the pH increase is small when H_2O_2 is added.

In the case of injecting air into the slurry (Fig. 3), the DOC is higher than DIW and the trend of DOC increase is similar to that of DIW. On the other hand, the pH is kept almost constant even when the air injection amount is increased.

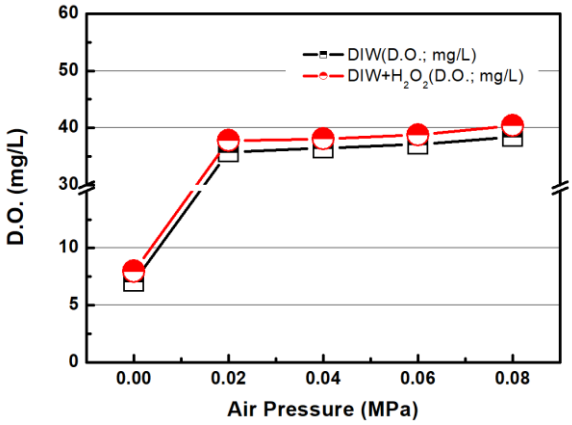

Fig.2 DOC change as a function of air pressure in case of DIW and DIW+H_2O_2

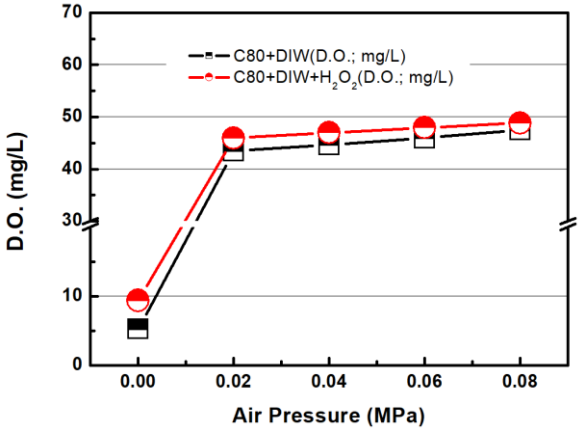

Fig.3 DOC change as a function of air pressure in case of silica slurry and silica slurry+H_2O_2

The proposed CMP method shows higher material removal rate (MR) than the conventional method.

5. Summary

This study proposes a CMP method using UV and dissolved oxygen. In this study, we implemented a device to implement the proposed method and confirmed its applicability through basic experiments. In order to obtain the applicability of the proposed system, more experiments should be conducted.

Acknowledgment

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (NRF-2018R1D1A1B07043169) and BB21+ Project in 2019. And, this work (S2658878) was supported by project for Cooperative R&D between Industry, Academy, and Research Institute funded Korea Ministry of SMEs and Startups in 2018.

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