Effects of H_2O_2 and glycine on WIWNU of TiN Chemical Mechanical Polishing under Weakly Alkaline Conditions

Yuanshen Cheng[1], Shengli Wang[2], and Chenwei Wang[3]
[1] Hebei University of Technology, 1157905281@qq.com
[2] Hebei University of Technology, shlwang@hebut.edu.cn
[3] Hebei University of Technology, wangchenwei@hebut.edu.cn

Abstract

In this paper, we found that the addition of H_2O_2 can increase the removal rate of TiN, resulting in the deterioration of within-wafer-nonuniformity (WIWNU) after polishing, because the addition of H_2O_2 can accelerate TiN corrosion. Glycine can suppress the TiN removal rate, leading to a better WIWNU because the addition of glycine passivates the TiN surface, which helps to obtain a high flatness surface.

Keywords: TiN; chemical mechanical polishing; Within-wafer-nonuniformity;

Introduction

In integrated circuit fabrication, barrier layers are essential to prevent the diffusion of interconnect metals ions into the underlying silicon substrate during high temperature annealing. As Co becomes a new generation plug/interconnect material when feature size decreases to 7nm and below [1-3], TiN has become the preferred barrier metal for Co plug/interconnects based on its many advantages, such as: a fair heat stability, a high melting point, good electrical conductivity and thinner and adequate thickness (2nm) [4-7].

Chemical mechanical polishing (CMP), which combines the advantages of chemical corrosion and mechanical wear, is currently the only and most effective way to achieve global and local planarization. Material removal rate (MRR) and within-wafer-nonuniformity (WIWNU) are the two most important output indicators of CMP process. The former reflects the processing efficiency and the latter determines the quality after polishing.

Corresponding Author:
Shengli Wang
Tel: +86 022-60201604
E-mail: shlwang@hebut.edu.cn
Hebei University of Technology, P.O. Box 300130
Tianjin, P. R China

With the continuous reduction of feature size, the depth of focus of lithography continues to shrink, and the requirements for local and global planarization of the polished surface become more and more stringent. Some areas will be over-polished or under-polished if the WIWNU is too large, resulting in circuit breakage or short circuit in this area, which directly reduces the yield in production. However, in the last decade, research on how to effectively improve the WIWNU of material removal has not been reported.

Thus, the aim of this study is to evaluate the effects of oxidant (the most common oxidant - H_2O_2) and complexing agent (the simplest amino acid - glycine) in slurry on the MRR and WIWNU during TiN CMP process. The corresponding mechanism was further explored.

Results and discussion

Table 1. The composition of the different slurries.

Slurry code	Composition
Slurry A	0.2wt% SiO_2 + 0.3wt% H_2O_2 at pH 7.5
Slurry B	0.2wt% SiO_2 + 0.6wt% H_2O_2 at pH 7.5
Slurry C	0.2wt% SiO_2 + 0.6wt% H_2O_2 + 2wt% glycine at pH 7.5
Slurry D	0.2wt% SiO_2 + 0.6wt% H_2O_2 + 3wt% glycine at pH 7.5

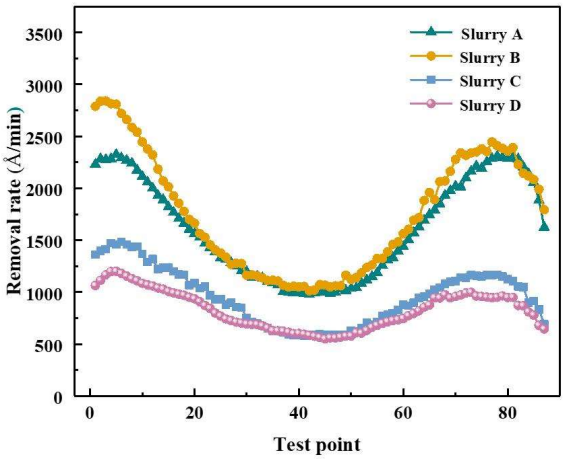

Fig.1 The removal rate profiles of TiN using four groups of different slurries.

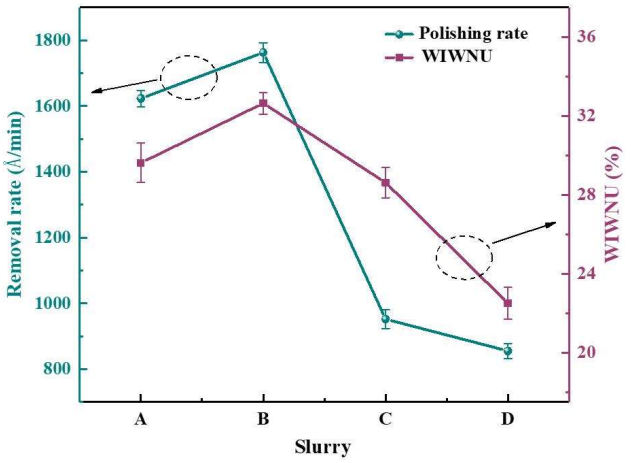

Fig.2 Effect of H_2O_2 and glycine on removal rate and WIWNU.

Reference

[1] F. W. Mont, X. Y. Zhang, W. Wang, J. J. Kelly, T. E. Standaert, R. Quon, E. T. Ryan, Cobalt interconnect on same copper barrier process integration at the 7nm node, 2017 IEEE International Interconnect Technology Conference (IITC), IEEE, 2017.

[2] R. Hung, J. H. Park, T. H. Ha, M. Lee, W. t. Hou, J. X. Lei, J. R. Bakke, S. Sharma, K. R. Sharma, A. Wachs, N. S. Kim, E. Yeh, Extreme Contact Scaling with Advanced Metallization of Cobalt, 2018 IEEE International Interconnect Technology Conference (IITC), IEEE, 2018, pp 30–32.

[3] R. Popuri, K. V. Sagi, S. R. Alety, B. C. Peethala, H. Amanapu, R. Patlolla, and S. V. Babu, Citric Acid as a Complexing Agent in Chemical Mechanical Polishing Slurries for Cobalt Films for Interconnect Applications, ECS J. Solid State Sci. 6(9), P594 (2017).

[4] H. Dixit, A. Konar, R. Pandey, and T. Ethirajan, How Thin Barrier Metal Can Be Used to Prevent Co Diffusion in the Modern Integrated Circuits? J. Phys. D: Appl. Phys. 50 (2017) 455103 (9pp).

[5] P. T. Liu, T. C. Chang, J. C. Hu, Y. L. Yang, and S. M. Sze, Reliability of Multistacked Chemical Vapor Deposited Ti/TiN Structure as the Diffusion Barrier in Ultralarge Scale Integrated Metallization, J. Electrochem. Soc. 147 (1) 368-372 (2000).

[6] L. C. Yang, C. S. Hsu, G. S. Chen, C. C. Fu, J. M. Zuo and B. Q. Lee, Strengthening TiN diffusion barriers for Cu metallization by lightly doping Al, Appl. Phys. Lett. 87, 121911 (2005);

[7] W. F. Wu, K. C. Tsai, C. G. Chao, J. C. Chen, K. L. Ou, Novel multilayered Ti/TiN diffusion barrier for Al metallization, J. Electron. Mater., 34(8), 2005.

Preference: ☑ Oral ☐ Poster

Topic Area: CMP fundamentals, modeling, and simulation