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Corrosion Action between Cu and Ta/TaN Barrier during CMP

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Abstract

Chemical mechanical polishing (CMP) is the promising method of achieving global planarization in the multi-level metallization process [1]. However, its mechanism is complex and the removal rate is hard to control, especially for the polishing occurring between different interconnect metals. Thus, the multiple-step polishing has been proposed improving the above problems [2]. Typically, for a two-step CMP in the Cu process, the first step of removing the bulk Cu cannot stop until the underlying barrier, such as Ta/TaN, is reached. After removing the bulk Cu, the slurry should be switched to perform the second step polishing because the polishing characteristics of the interconnect and barrier metals are so different. For example, the Cu is more sensitive to corrosion and softer than the Ta/TaN barrier. In the second step, the polishing of the exposing barrier and the remaining Cu are referred to the overpolishing, and this step should be maintained under the equal removing ratio of Cu to Ta/TaN until the barrier is removed [3]. However, the composition of the second slurry and the electrochemical mechanisms may be further complicated. Therefore, understanding the corrosion action between Cu and Ta/TaN barrier is critical to the Cu metallization process.

This study investigated the corrosion characteristics of Cu, Ta and TaN in various slurries by measuring polarization curves. The experimental results show that the corrosion current densities of Ta and TaN are closer to Cu in U-H_2O_2 + HBTA slurry because H_2O_2 promotes the dissolution of Ta to $Ta(OH)_x^{(5-x)+}$ [4], and meanwhile HBTA inhibits Cu, as shown in Fig. 1. However, the high galvanic corrosion between Cu and Ta/TaN, with the larger difference in their corrosion potentials, would make Cu deposited on the barrier, then result in a confused end-point detection, or even failure of the diffusion barrier. Fig. 2 shows that corrosion current densities of Ta and TaN are still close to Cu in U-H_2O_2 + HBTA slurry with NH_4OH, while the difference in corrosion potentials of Cu and TaN decreases. However, the corrosion potential of Cu become lower than Ta, it means the interaction between Cu and Ta might result in the accelerated dissolution of Cu and the retardant oxidation of Ta.

When one chelator was added to the slurry, the corrosion current densities show larger difference between Cu and Ta/TaN and lower galvanic corrosion rates. Meanwhile, the corrosion potential as shown in Fig. 3 indicates that Ta and TaN are oxidized rather easily than Cu. Furthermore, the effects of the other slurries and additives on corrosion action between Cu and Ta/TaN have also been explored in this study

Reference

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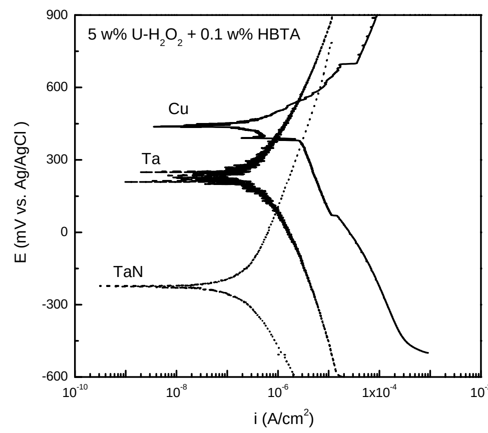

Fig. 1. Polarization curves of Cu, Ta and TaN in 5 w% U-H_2O_2 + 0.1 w% HBTA slurry.

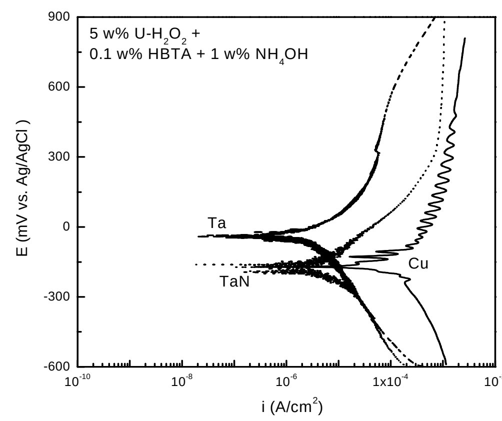

Fig. 2. Polarization curves of Cu, Ta and TaN in 5 w% U-H_2O_2 + 0.1 w% HBTA + 1 w% NH_4OH slurry.

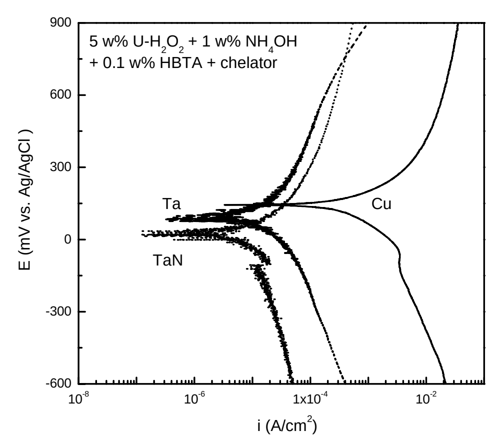

Fig. 3. Polarization curves of Cu, Ta and TaN in 5 w% U-H_2O_2 + 0.1 w% HBTA + 1 w% NH_4OH + chelator slurry.