The Control of Topographical Selectivity in Pd-Activated Electroless Copper Deposition

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In recent years, the damascene copper (Cu) electroplating has been developed to replace the conventional aluminum-base metallization in memory and logic-device manufacturing process. This electrolytic plating method is less expensive and less complicated in conditioning the process than CVD or sputtering. However, in current semiconductor processing, the electro-deposition of copper usually requires metal seed layer because copper is hardly electroplated directly on barrier layers such as TiN and TaN. Various deposition techniques such as sputtering, MOCVD, and electroless deposition have been proposed for the preparation of a thin metal seed layer [1,2], among which the electroless deposition of copper has drawn much attention because of its low cost and high adaptability to the electrolytic deposition that comes in next sequence.

In the 199th ECS meeting, we have presented the effect of cleaning and pre-treatment on the Pd-activated electroless copper deposition on the patterned TiN substrate [3,4]. Especially, we have described the effects of pre-treatment conditions on the growth of copper. In our experiments, we were able to control the population and the topographical location of palladium particles by the variation of palladium pre-treatment and post-treatment conditions. The size of palladium particles is also to be modulated with varying process temperature. As shown Fig. 1(a), in case of conventional Pd-activation process, which has been performed around room temperature, the copper has uniformly grown on the patterned wafer. However, figure 1(b) shows copper has selectively grown only in the vias and trenches, when palladium particles are positioned and grown in the via holes and trenches.

We have further studied on the selective copper growth process to find out the definite process conditions. Furthermore, we have studied on the quality of selectively grown copper such as the adhesion, contaminants, step coverage, and so on. Figure 2 shows the selectively growing copper in the vias. From this result, we are able to estimate that the specific palladium pre-treatment condition, which palladium has selectively grown in the via holes, bring to the selective copper growth in the vias/ trenches. Figure 3(b) shows the copper is mainly growing in the around of palladium particle. In the presentation, we will discuss on the mechanism involved in the topographically selective electroless copper deposition.

References

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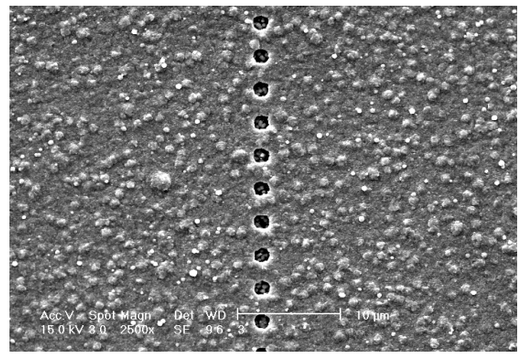
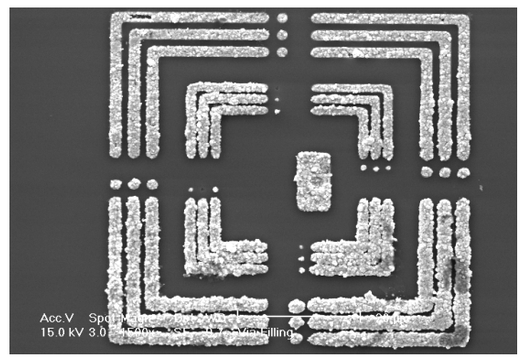


(a)



(b)

Figure 1. The different patterns of copper growth in the different palladium pre-treatment conditions; (a) the conformal copper growth and (b) the selective copper growth

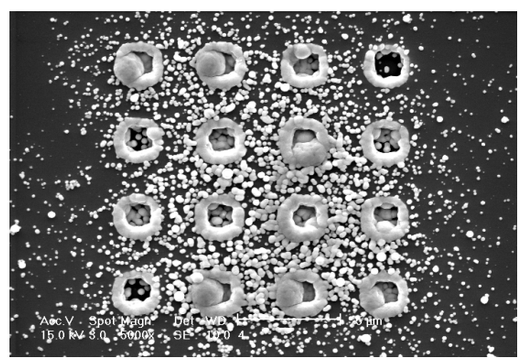
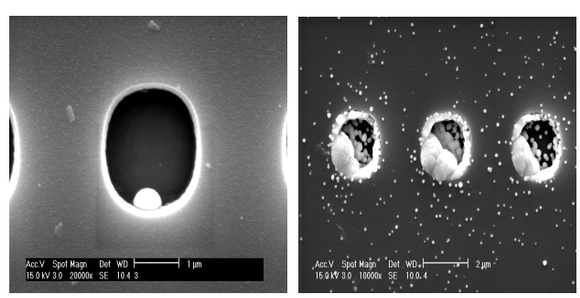


Figure 2. The progress of selective copper growth in the via holes



(a) **(b)**

Figure 2. The effects of palladium particle on the selective copper growth; (a) The growth of palladium particles in the via holes, (b) The selective copper growth in progress