FORMATION OF COPPER DOTS IN COPPER DECORATION TECHNIQUE

By

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Contents

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ABSTRACT

Copper ions are dissolved from highly pure copper plate into the methanol during copper decoration process. As a result, copper concentration in methanol is increased with time. The copper concentration in methanol measured by ICP-OES is correlated well with the calculated value based on the magnitude of current and time during the process. Consequently, higher magnitude of current can be applied to build up copper concentration in methanol in shorter period.

When copper ions are ejected in methanol, they are positively charged. They experience force from electric field and migrate towards oxide surface. Eventually, these copper ions will be discharged and deposited at localized breakdown spots on oxide surface as copper dots. These copper dots are surrounded by grey ring. TOF-SIMS analysis on these copper dots shown that Na, Mg, K and Ca are responsible for the formation of the grey ring.

Copper dots are formed on oxide breakdown spots when oxide layer is subjected to stress field. When these defects are subjected to constant field, weaker spots will breakdown. In fact, these permanent damages are created not only at the oxide but extended to the wafer surface. Damages on wafer surface can be revealed and enlarged by preferential etching. These damages also provide localized conducting paths that allow electric current to flow through the oxide layer. Since electrons are supplied to these breakdown spots, copper dots are formed on wafer surface.

It is believed that defects integrated in the oxide layer degrade the oxide layer differently. This phenomenon is observed when higher defect density of copper dots is obtained with increasing of applied field. When higher electric field is applied to the oxide layer, those weak spots that do not breakdown initially will not be able to withstand the stress field. Consequently, more copper dots will be grown on the wafer surface. In addition, different size of copper dots on copper decorated wafer further support the above hypothesis.

The existence of the peak on the copper dot can be due to the oxide underneath the copper dot peak is the origin of a localized breakdown spot. Therefore, the spot has longer time for copper ions deposition. Moreover, the oxide underneath the copper peak might experience most severe breakdown. This allows higher current density to flow through it. Consequently, more ions are deposited at the particular spot and copper dot's peak is formed on the oxide surface.

Our experimental results also show that copper concentration in methanol plays an important role in copper decoration technique. Increasing of copper concentration is correlated with increasing conductivity and increasing of the average size of the copper dots. By controlling copper concentration in methanol in a proper range, it is possible to obtain repeatability and reproducibility copper decoration results.