EFFECT OF ACIDITY ON REDUCTION OF DEFECTS IN ELECTROPLATED CU FILM

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The identification and elimination of defects in electroplated copper films become increasingly important as these defects are revealed to be potential yield killers. The “swirl defect” is one of the most important defects in electroplated copper films, which consists of pits clustered together to form curved lines such as arc in shape. It is uniquely related to the electroplating process and is associated with the incomplete wetting of the copper seed surface at the beginning of plating. In this study, the effect of acidity of the plating chemistry on reduction of the swirl defects was investigated.

A set of blanket and patterned wafers was plated in separate lots using the chemistry with high acidity, and the other set was prepared using the chemistry with low acidity. Selected number of wafers in both sets underwent pre-treatments prior to the beginning of plating in order to find the optimum condition of eliminating the swirl defects. Defect monitoring and identification was carried out with commercially available in-line laser based inspection tools and analytic techniques including scanning electron microscope (SEM).

The comparison of the total defect count shown in Fig.1 indicates that the use of the low acid plating chemistry improves the defect performance as compared to the use of the high acid chemistry. A typical defect map and SEM top view image of an electroplated copper film with swirl defects is shown in Fig.2. The relative numbers of wafers and dies with the swirl defects are summarized in Fig.3. For the copper films plated using the low acid chemistry, the numbers of wafers and dies with the swirl defect were greatly reduced as compared to those prepared using the high acid chemistry. Results of pre-treatments prior to the beginning of plating are shown in Fig.4. While the wafers and dies with the swirl defects were not observed with the pre-treatments for the high acid plating chemistry, the pre-treatments were ineffective and even increased the relative numbers of the wafers and dies with the swirl defects for the low acid chemistry. Other types of defects and SEM pareto for each plating chemistry will be discussed in this paper. In addition to the defect performance, other film properties including the gap fill will be compared and discussed in detail.

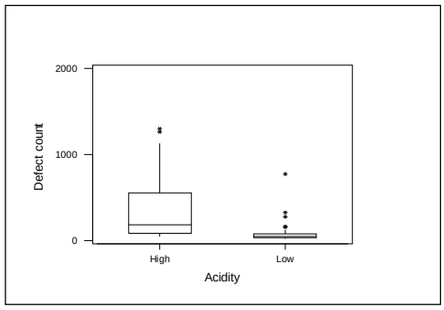


Fig. 1 . Total defect counts for copper films plated using chemistries with different acidity

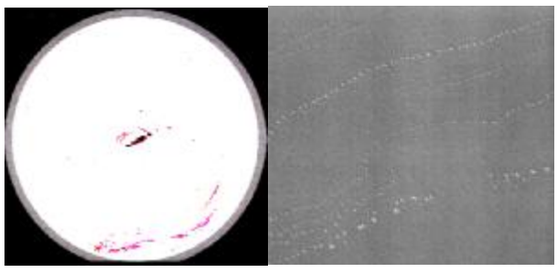


Fig. 2. Defect map and SEM top view image of copper film with swirl defects

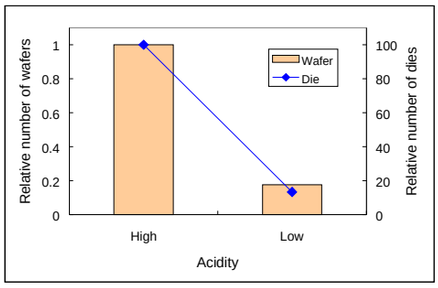
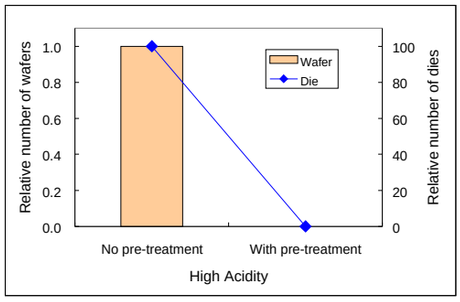


Fig. 3. Relative numbers of wafers and dies with swirl defects



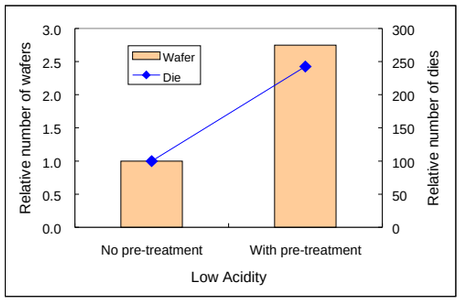


Fig. 3. Relative numbers of wafers and dies with swirl defects

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