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上海华力 HLMC

DISHING STUDY ON CHEMICAL MECHANICAL PLANARIZATION (CMP)

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ABSTRACT

Dishing as the unavoidable side effect in the process of CMP has an important impact on the wafer loading and process window. Dishing always comes from the high selective ratio of slurry. The paper presented the dishing theoretical model and the influence factor, and offered the direction for the improvement of dishing in CMP. Furthermore, the experiment in the paper shows that the surrounding and location of monitor pad designed for dishing characterization also play an important role in dishing quantification.

INTRODUCTION

We summarize two similar forms of dishing calculation from GuangHui Fu and Nguyen's research:

$$D(t) = (1 - e^{-At})B \qquad (1)$$

$$D(t) = (Ct + 1 - e^{-At})B \qquad (2)$$

The "A","B","C" of (1) and (2) are coefficients influenced by multiple factors such as pressure, relative velocity, selective ratio of slurry.

We also optimize the AFM measurement recipe to measure the dishing of bond pad in STI loop.

METHODOLOGY

Firstly, to verify the rationality of (1) and (2), we over-polish the same 300 mm wafer with different time. The CMP main parameters are shown in Table 1. The size of monitor pad is 40*80 μm and four monitor pads are arranged in STI region. The CMP machine type is AMAT Reflexion LK. And we use AFM to measure the size of dishing.

In the next experiment, we collected the measurement data of bond pad of different AFM recipes. Then we sliced wafer to check the accuracy of AFM measurement data. In order to reduce the influence of process fluctuation on experimental results, we measured 5 points on the same wafer.

Table 1: CMP main parameters

Platen RPM	Head RPM	Head Sweep	Slurry(CES-5003) flow rate	Pressure
73	67	Sine 19 swps/min	300 ml/min	1.06 psi

RESULTS&DISCUSSION

Verification of Dishing Theoretical Calculation

Our dishing data can only be fitted with formula (2) but cannot be fitted with formula (1). The fitting results are shown in the Figure 1. The results show that in the large STI region, dishing increases almost linearly with the increase of over-polish time within 80s which means that (2) is more suitable for calculating dishing of large size linewidth.

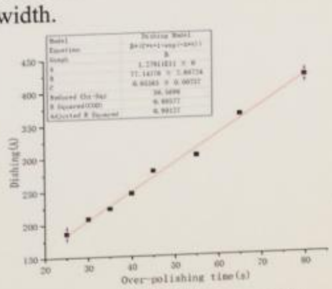

Figure 1: Fitting results

Optimization of AFM Measurement Recipe in STI Loop

The relative positions of different bond pads in Figure 2. One conclusion can be drawn by comparing the AFM data with TEM slice data shown in Table 2: The data obtained by back-leveling method is much more matched with TEM slice results.

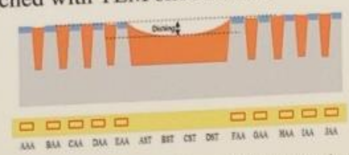

Figure 2: Relative positions of different bond pads

Table 2: dishing based on EAA-AST

Die	TEM	Front-level	Back-level
(0,-4)	126	320	175
(3,2)	205	232	191
(0,2)	80	143	88
(0,-2)	170	202	183
(0,0)	226	259	218
Average	161	231	171

SUMMARY

In this paper, we explore the topography of bond pad array and optimize the AFM measurement recipe in STI loop. Our experiment shows that taking STI area as the datum line is better than taking EAA pad. Besides, we extract two simple forms of calculating dishing changing with over-polish time from the work of Guanghui Fu and V. H. Nguyen. And we find that $D(t) = (Ct + 1 - e^{-At})B$ could accurately describe the variation trend of dishing in the large line width region.