CHAPTER VI

CONCLUSION AND RECOMMENDATION

6.1. Conclusion

The RIE post-etched redeposit removal process was determined to be a chemical process in nature. There were 2 key process input parameters that determine the removal efficiency:

- Cleaning solution concentration (%w/v)
- Cleaning time (min)

Both of 2 key process parameters were examined in this study. Varying of the cleaning solution concentration and the cleaning time were conducted for monitoring their effects on the defect rate and cleanliness quality along the etched sidewall. (Note that in this study, the other process parameters such as incoming parts cleanliness, scrubbing force, and scrubbing stroke were previously investigated to have lesser effects and were kept constant during this evaluation.)

SEM and AFM were selected as the primary cleanliness measurement tools due to their ability to physically resolve sub-micron range of redeposit material. Electrical tests at the component and drive level were used to delineate the effects on the electrical performance of the device. Numerous statistical analysis techniques were used for to quantify the collected data in order to make the comparisons. Following is a summary of the impact to the physical and electrical performance of the selected cleaning process.

6.1.1. Impact Study in Terms of Physical Characterization

The new cleaning recipe impact as detected physically by SEM and AFM enable the following observations:

1. Increasing of NaOH concentration and scrubbing time resulted in the increased redeposit removal efficiency; and
2. 0.05% NaOH and scrubbing time of 12 minutes are the optimum of concentration and time that can be used to clean the slider without creating any alumina pitting defects.

Higher concentration of NaOH was found to be more effective in cleaning because the higher contribution OH^- ion could remove more residue from etched sidewall. The longer scrubbing time also gave a better removal effectiveness by providing an additional forces to overcome the adhesion force between the redeposit and the substrate surface. However, there is a limit to which the NaOH concentration and scrubbing time can be used. This limit was determined by their side effect of inducing alumina pitting. From this study, a 0.05% NaOH and scrubbing time of 12 minutes process provides the best cleanliness results on etched sidewall without negative impact of alumina pitting on read-write head.

SEM EDS analysis showed that the redeposit was made up of fluoride ion that was created by the CF_4 gas during the etching process. With higher NaOH concentration, there will be more OH- ions that will improve the fluoride-containing redeposits removal effectiveness. Elimination of any fluoride-based residue is required in the HDD industry.

6.1.2. Impact Study in Terms of Electrical Characterization

The new process 0.05% NaOH provided not only better cleanliness but also provided better QST yield and DET yield. This suggested that the new cleaning process not only improved the cleanliness effectiveness but also improved the electrical performance both of "reader" and "writer".

In terms of impact to the final HDD product, the new process has been shown to reduce the ETD and TD failure rates which both will effectively improve the final product yield and performance reliability.

The electrical yield and defect was taken into account because they are directly related to manufacturing cost. Once we can improve cleanliness, make the higher electrical yield, and reduce the failure rate, this meant we could be able to reduce the manufacturing cost and also improve device reliability..

6.2 Recommendation for future work

To expand on this work and further improve the redeposit removal efficiency, the following two key learning are proposed for future works. Firstly, the additive solution that can be added to the NaOH to reduce the alumina pitting generation can be explored. This will enable the use of higher NaOH concentration and/or scrubbing time and increate the amount of redeposit to be removed. Secondly, more fundamental investigations on the chemical interactions between the NaOH and redeposit would further elucidate the removal process mechanism. Thus it will provide thermodynamics and kinetics understanding needed to explore new cleaning approach to this problem in general.