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Wafer Reclaim Processing

Introduction

Wafer reclaim is typically defined as “a silicon wafer that has been processed, then stripped, sometimes polished, and then cleaned; can be reprocessed for a different use” [1]. Wafer reclaim includes the process steps that are required to transform a wafer that has been used and have multiple layers of various materials into a useable test or qualification wafer at a lower cost than buying a new wafer for these purposes. Thus, a key driver for wafer reclaim is wafer cost. As wafer diameters increase, wafer reclaim has become an increasingly important part of the fabrication strategy. Most 200mm production fabs employ reclaim as part of their test wafer strategy. 300mm wafers are far more expensive than 200mm wafers; therefore customers increasingly include wafer reclaim in their wafer recycling strategy. Test wafer usage as a percentage of total wafers in process varies from fab to fab, often increasing at fab or technology start up and decreasing as technology development matures and as fab processes stabilize. Commonly there is one test wafer in use for every 3 production wafers but this will vary widely. Not all test wafers are reclaimed wafers – it is thought that 70% of test wafers will be reclaim at 300mm [2].

Some IDM (integrated device manufacturers) outsource their wafers for reclaim processing. At 300mm, several IDM companies are exploring in-house reclaim processing to save cycle time. In both cases, preservation of silicon, wafer flatness and particle performance are key to increasing the number of times that a wafer can be reclaimed.

Process Sequence

Typical steps in a reclaim process, however variations of the this process are know, but usually include:

Sort

The sorting step is critical to prevent metallic contamination in the reclaim line. Contamination will be discussed in more detail in the following sections. Sorting usually starts with 100% inspection of incoming wafers including visual inspection, wafer type determination, and measurement of dopant and mechanical parameters. This step determines the subsequent reclaim processing steps.

Strip

The strip step will depend on the condition and previous processing of the incoming wafers. Typically, the strip step is performed in automated wet immersion batch tanks, such as the Orca™. The processing steps include SPM (sulfuric acid, hydrogen peroxide mixture), concentrated HF etch, and alkaline etch, typically KOH. Nitric or



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phosphoric acid may be used depending on the incoming material. Additional pre-treatment may be required for wafers with metal films. The SPM and phosphoric acid cleaning process are outline in other sections of this technical guide. It is critical that the film removal equipment keep wafers safe from cross contamination.

Lapping and Grinding

Grinding may be required for thick SOI (silicon on insulator) wafers and to remove other films. Lapping and edge rounding are also often performed on the reclaim wafers. The grinding process is similar to CMP (chemical mechanical processing) but with a faster removal rate with less uniformity. After this step, a smoothing step with better uniformity and a final polish is performed.

Polish

Polish may be single or double side polishing, which often uses a combination of chemical and mechanical polishing. Double sided polishing may produce the lowest TTV (.total thickness variation). The surfaces of the wafers are now bare silicon, thinner than the original thickness of the wafer, and ready for the final cleaning steps. The polishing step can leave residual slurry and unwanted particles and metallic contaminants on the wafer and these must be removed.

Clean

The final cleaning step is performed in batch immersion tanks. Typically the full cleaning process is performed sequentially in one cleaning bath. The Orca™ is the recommended tool for this step. The RCA critical cleaning process is outlined in other section of this technical guide. The multiple stages cleaning process includes SC-1 (a combination of H₂O: NH₄OH: H₂O₂) for particle removal. SC-2 (H₂O:HCl:H₂O₂) may also be used to clean the wafers to reduce the metal levels to less than 5E10 atoms/cm², usually the levels obtained are less than 1E10. A surface tension dryer is used to dry the silicon wafer as the final step.

Inspection

The wafers are again sorted by thickness and defect level before being returned for use in the fab. Typical defect levels are <50 defects measured as LPD's at 0.12µm. Defect performance is critical because test wafers are often used for troubleshooting equipment and process particle problems in the fab .

Figure 1 outlines the entire reclaim process.

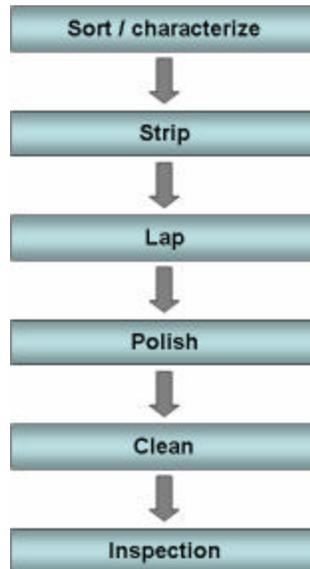


Figure 1. Outline of the wafer reclaim indicating the key processing steps.

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Contamination

It is critical to identify and segregate copper-containing wafers from aluminum wafers to prevent contamination. Lapping may not remove all Cu from the wafer edge [3]; therefore chemical processing is a critical part of managing Cu wafers. Copper wafers must use dedicated film removal equipment. Further, HF solutions encourage Cu deposition on silicon [4]. Baths may contain oxidizers and chelating agents to prevent the redeposition of copper onto the silicon surface [3].

Special requirements for 300mm

With the increased cost of 300mm wafers, single wafer tracking within the reclaim facility may be required to carefully track the processing of the wafers and identify any contaminated wafers. Identification of the processing wafers at each piece of equipment is important. Sophisticated cassette and wafer ID readers may be integrated into the processing tool.



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Conclusion

Wafer reclaim is used for both 200 and 300 mm by high volume manufacturing companies to significantly reduce the cost of purchasing new wafer for test and qualification wafers. Wet cleaning processes are required in addition to other process steps to successfully reclaim wafers with multi-film stacks for further usefulness. The process equipment for reclaim includes the stripping station and the critical cleaning station. Typically, both systems are automatic batch immersion wet tanks. The Orca™ platform is suited for both process steps and can be custom configured to suit any processing need for reclaim.

References

1. *ITRS Roadmap*, 2006 Update.
2. Tucker, Michael T. and David Lewis. Future Fab International, Volume 12 "The Requirements for Successful 300mm Wafer Reclaim" 2/2/2002.
3. "Evaluating wafer reclaim techniques in emerging copper processes" MICRO
4. Morinaga, H., Suyama, M., Ohmi, T, "Mechanism of Metallic Particle Growth and Metal-Induced Pitting on Si Wafer Surface in Wet Chemical Processing," *Journal of the Electrochemical Society* 141 (1994).