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OVERVIEW

- Aluminium (Al) is the most common interconnect material in fabrication but it suffers from performance limitation due to its high resistance-capacitance (RC) delay.
- In 1997 copper (Cu) replaced Al because it has a lot of benefit. Major benefit of Cu :
  - Cu has a very low resistivity (1.70 $\mu\Omega$. cm), which means lines can be smaller and packed more tightly but still carry the same current.
- This transition has meant that semiconductor companies have to deal with fab cross-contamination concerns by building separate cleanroom facilities for the processing of Cu wafers. However, manufacturing economics do not favour the idea of having separate Cu and Al processing manufacturing lines for wafer fabs.
- Caused by the concerns of Cu cross-contamination, many semiconductor manufacturers have been reluctant to deal with shared production lines.
- Hence, maintaining a precise control of the items which relate to Cu processes in a shared line is very important and a big challenge to establish a control system to ensure Cu and non-Cu are not intermingled.
- For the above reasons, this study investigated control of a shared tool through Tool Conversion Request (TCR) protocol method. This control protocol can further reduce the jeopardy of Cu contamination by helping to prevent a mismatch standard of mechanical interface (SMIF) pod to SMIF port.

Implementing Tool Conversion Request (TCR)
Protocol to Ensure the Effectiveness of Copper Contamination Control.

RESULTS

- Either Cu or non-Cu tool that require converting to non-Cu or Cu and vice versa must follow the procedures below :
  - Requisition application.
  - Pre- and post-Total X-ray Fluorescence (TXRF) qualification.
    - To measure the amount of Cu.
  - Pin configuration and verification.
    - A hardware method, accomplished by using different pin sizes incorporated onto SMIF port plates as Figs. 1,2 and 3.
  - TXRF verification.
    - A software protection, which is a technique to evaluate Cu contamination. A non-Cu wafer is shown in Fig. 4. However, it will indicate a contaminated region if wafer has Cu contamination as illustrated in Fig. 5.
  - Port-class release.
    - To guarantee a request conversion is successful by giving permission to SMIF pod put on the new status of SMIF port. Port-class conversion as Figs 6 and 7.

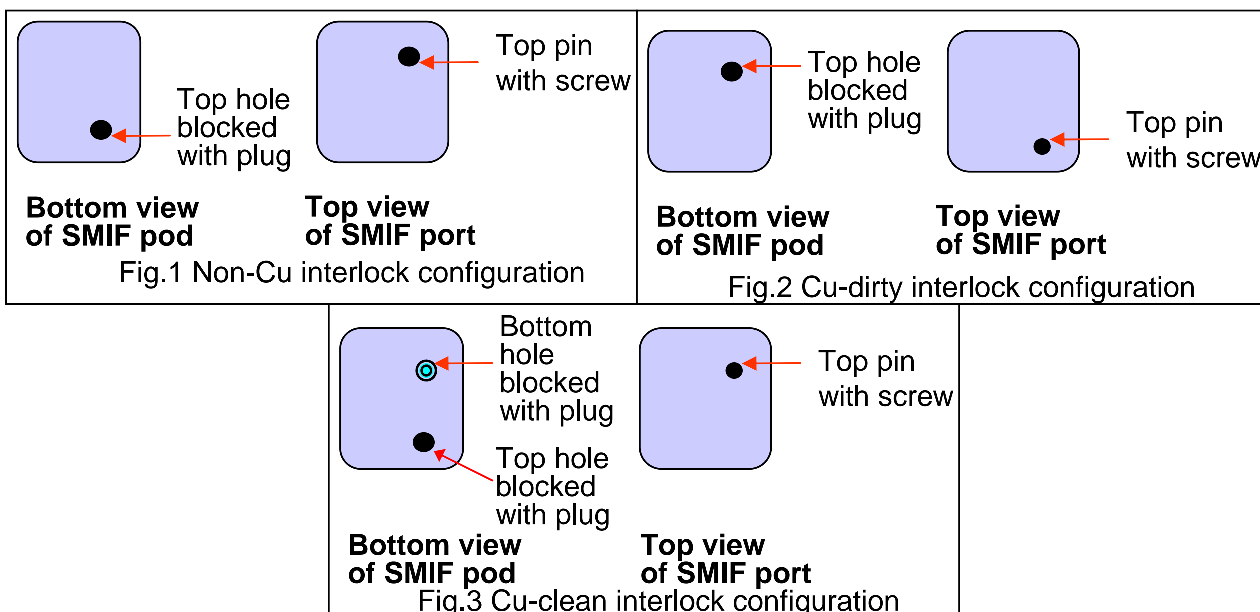

Fig.1 Non-Cu interlock configuration

Fig.2 Cu-dirty interlock configuration

Fig.3 Cu-clean interlock configuration

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RESULTS

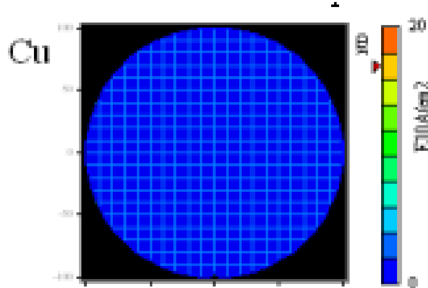

Fig. 4. Non-Cu wafer

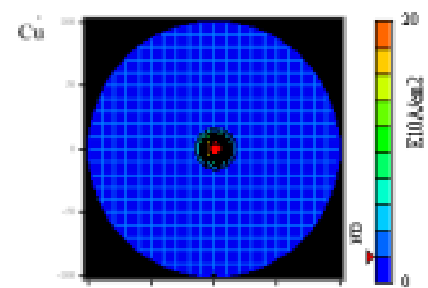

Fig. 5. Wafer with Cu contamination.

Fig. 6. Original port class status (before conversion)

Fig. 7. Converted port class status (after conversion)

CONCLUSION

- We propose a method to control Cu contamination by applying a TCR protocol. With this method, we demonstrated step by step procedures for a shared tool.
- The goal of this method is to minimize the potential risk of Cu contamination to the existing fab line while keeping the budget as low as possible. In addition, this method would play a key role in the prevention of cross-contamination between Cu and non-Cu tools.
- As a conclusion, it has been demonstrated that existing high volume non-Cu wafer fabrication facility can successful combine with Cu by adapting TCR protocol. It starts by conversion request and continue with TXRF qualification, pin configuration and verification, TXRF verification and port-class release.