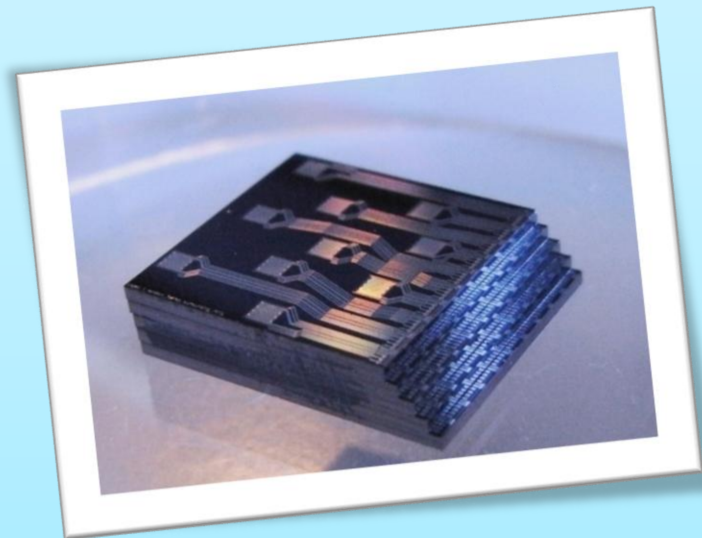
Electrical Characterization of Cu TSVs with Low Temperature Cu/Sn-BCB Hybrid Bonding



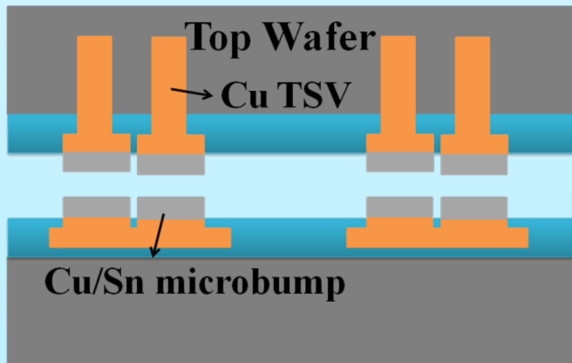
Student: Tsung-Han Yu 游宗翰
Supervisor: Kuan-Neng Chen 陳冠能 教授

Ⅰ. Introduction

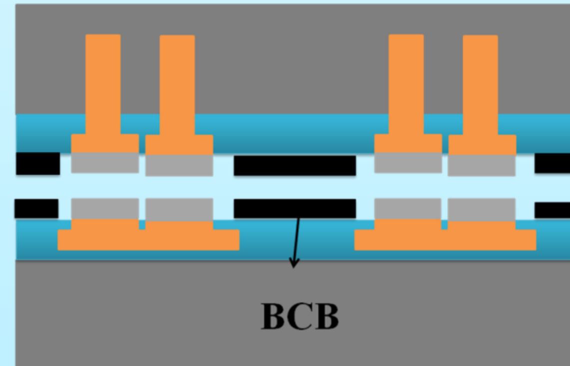
A wafer-level 3D integration structure with Cu TSVs based on Cu/Sn/Cu eutectic bonding and BCB hybrid bonding is demonstrated.

Kelvin structure and daisy chain design are adopted for electrical characterization and reliability evaluation.

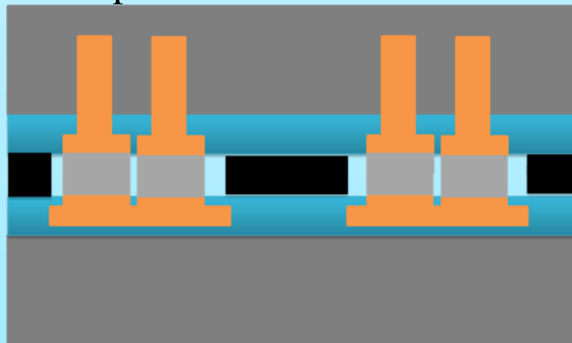
Ⅱ. Process Flow and Integration Scheme

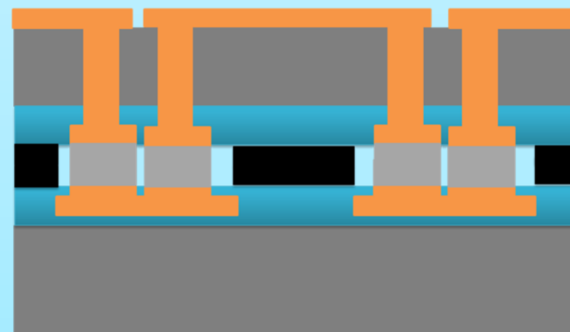


(a) Cu/Sn microbump scheme on the top and bottom wafer



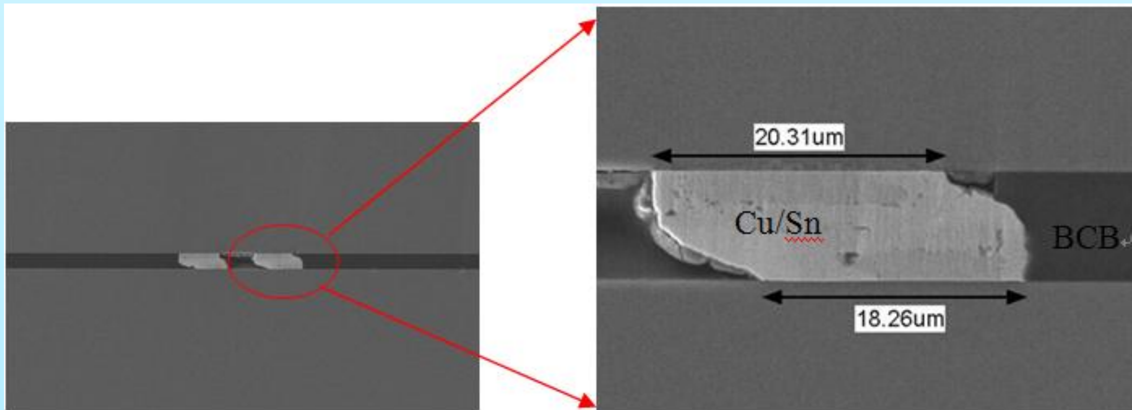
(b) BCB spin coating and lithography


(c) Cu/Sn and BCB hybrid bonding

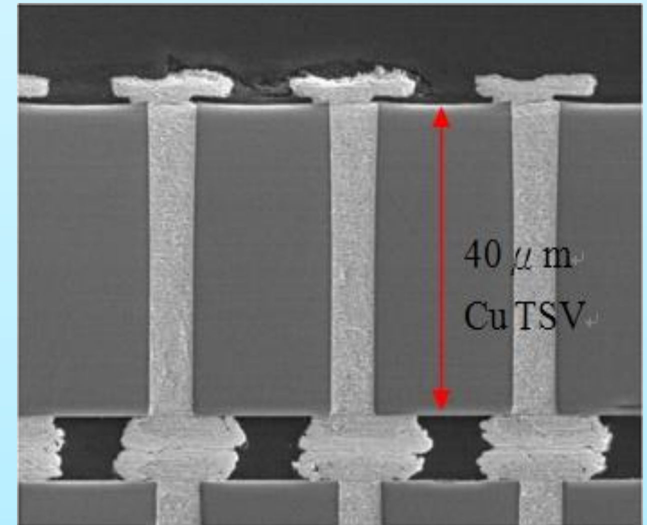

(d) Wafer thinning and backside metallization

◆Demonstration of Cu/Sn & BCB Hybrid Bonding

- No interface exists at BCB-BCB bonding surface
- Thickness control of Sn → no Kirkendall voids

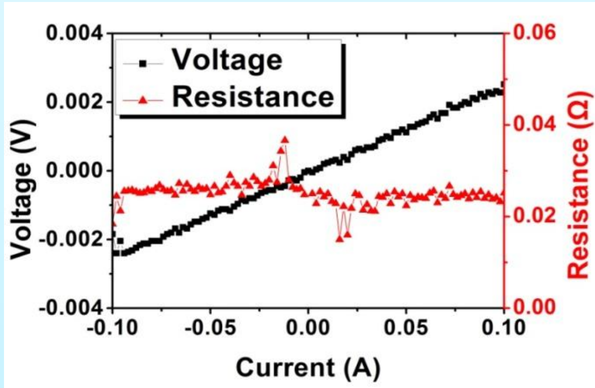


(a) SEM image

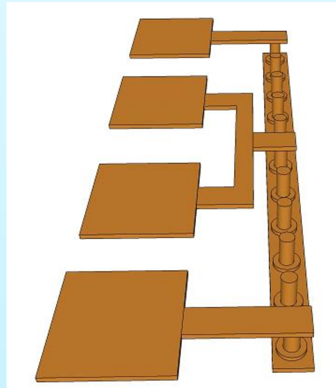


(b) SEM image of Cu TSVs

Ⅲ. Electrical Characteristics of Cu TSV with Hybrid Bonding

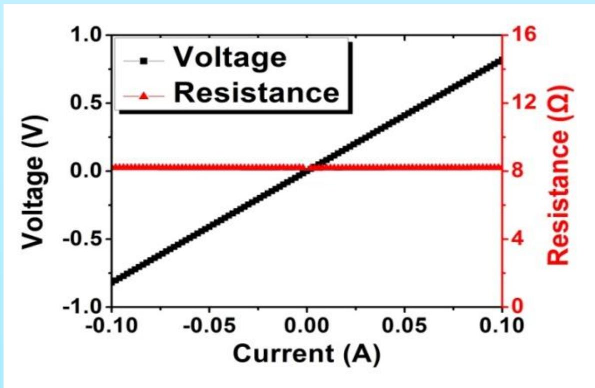


(a) V-I & R- I curves

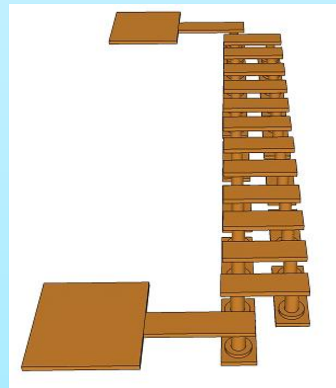


(b) Kelvin structure design

$$R_{kelvin} = R_{10\mu m\ TSV} + R_{Cu/Sn\ microbump}$$



(c) V-I & R- I curves

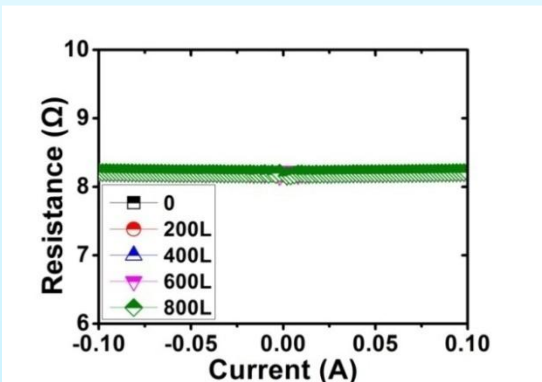


(d) Daisy chain design with N=100 via chains

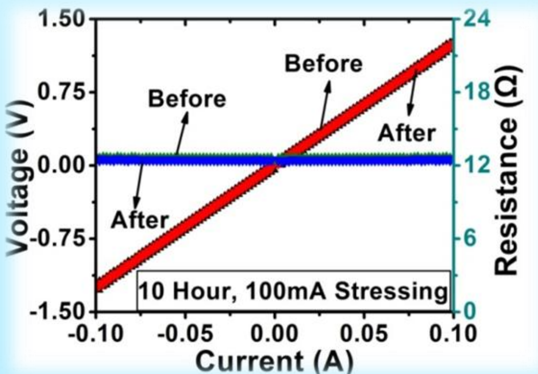
$$R_{daisy\ chain} = N \cdot (R_{Cu\ TSV} + R_{Cu/Sn\ microbump} + R_s)$$

- ➢Kelvin structure = single TSV + micro-joint structure
- ➢Daisy chain → evaluate bonding integrity & integration performance
- ➢70%↑ of $R_{daisy\ chain}$ is contributed by $N \cdot R_s$, connected interface, bonding structure

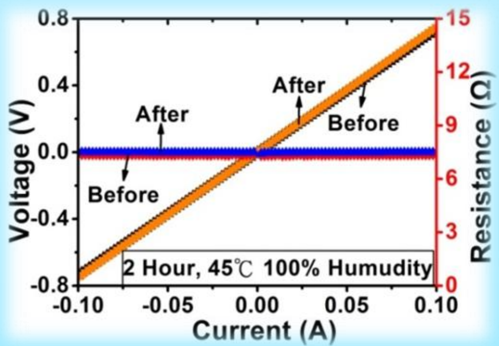
Ⅳ. Reliability of Electrical Stressing and Humidity Test



(a) Multiple current stressing

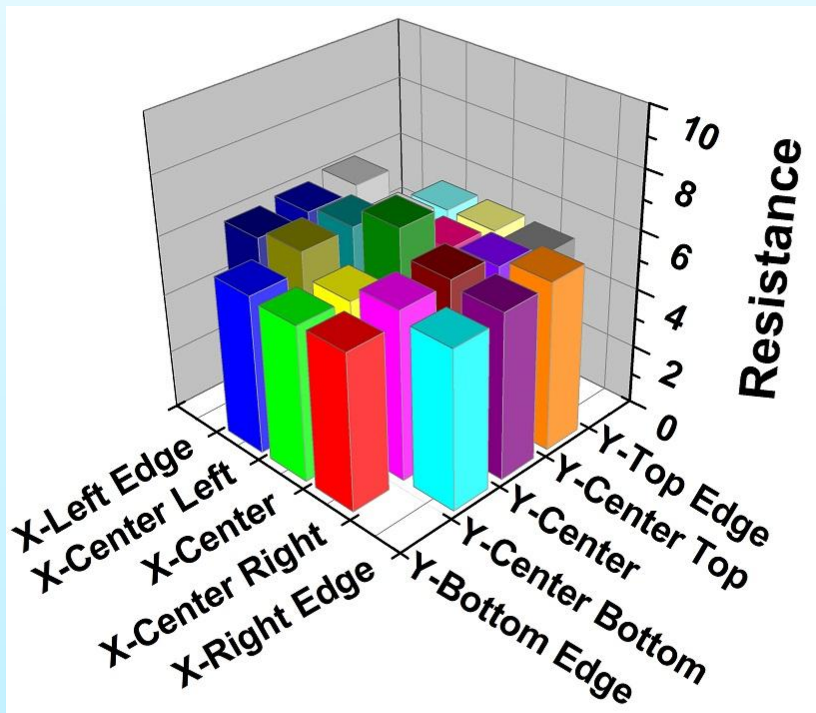


(b) 10hrs constant current stressing



(c) 2hrs, 45℃ & 100% humidity test

- Multiple current stressing(N=100) → excellent stability even after 800 cycles stressing
- Constant current stressing(N=150) → no obvious deterioration after 10 hrs stressing
- Humidity test → no apparent perturbation
- This 3D integration scheme possesses excellent reliability & electrical stability.



Characteristics of total resistances of N=50 via chains and locations on wafer

- Small deviation → good uniformity & integration performance

V. Conclusion

The advantage of Cu/Sn/Cu eutectic bonding and BCB hybrid bonding includes low bonding temperature and strong bonding strength.

Kelvin structure and daisy chain design are adopted for electrical characterization and reliability evaluation including *multiple current stressing*, *constant current stressing* and *humidity test*. The results indicate the developed 3D integration has excellent reliability and electrical stability, which is of great use to future applications.