

Hybrid Cu-Cu Bonding with Non-Conductive Paste and Highly (111)-Oriented Nanotwinned Copper

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Abstract

In recent years, hybrid Cu-Cu bonding has attracted a lot of attention because it can be scaled down below sub-micron. Hybrid bonding with silicon oxides has been adopted for interconnects of CMOS image sensors. However, the process is very complicated and not cost effective.

In this study, a bump-to-film structure is used for feasibility test. Nanotwinned copper (nt-Cu) is a candidate for low-temperature Cu-Cu bonding. Highly (111)-oriented nt-Cu can be electroplated with good uniformity on Si wafers. With the high surface diffusivity and the low oxidation rate, the bonding can be achieved at lower temperature in the same time. The Cu-Cu bonding temperature can be reduced by using nt-Cu. No-flow non-conductive paste (NCP) is a candidate to be used as the filling materials for the hybrid bonding, which can be dispensed in the room temperature and can provide protection to the bonding interface effectively. The no-flow NCP is dispensed in room temperature and screw bonders are used to exert force. The bonding temperatures are 150, 180, 200, and 250°C with times in the range of 20 to 60 min by tube oven in the air.

In the experimental condition, the bonding can be achieved successfully in the air, and the lowest temperature can be reduced to 150°C. The good filling of NCP can provide protection effectively. The advantage of no-flow NCP and the nt-Cu can be conducted simultaneously.