Proceedings of the Canadian Society for Mechanical Engineering International Congress 2022
CSME Congress 2022
June 5-8, 2022, Edmonton, AB, Canada

Investigation of methods of through silicon via filling using conductive paste and silver nanowires

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ABSTRACT

Through silicon via (TSV) has been emerged as a promising technology for 3D integration in various MEMS sensors and actuators, allowing vertical electrical connection in a silicon wafer. The benefits of TSV are quite notable, as it helps with a reduction in chip sizes, lower power requirements, and enhanced bandwidth. The current filling method of TSVs based on electrodeposition or chemical vapor deposition has several limitations, including being expensive, requiring highly sophisticated equipment, time consuming, and still being susceptible to filling defects.

In addition, the chemical mechanical polishing (CMP) process, which inevitably follows the filling process is costly and difficult to maintain. A promising candidate for TSV filling that is being investigated is the conductive silver paste. The use of conductive paste could provide a lower cost, faster alternative to semiconductor TSV fabrication and could become an important fabrication method in the future.

Major challenges in the conductive paste filling technology include the formation of air gaps, shrinkage of the conductive paste after curing, high viscosity, and relatively high resistivity. In this research, a highly efficient and low-cost, one-step filling process is developed using an electrically conductive silver paste of different conductivity and viscosity. Three conductive pastes with varying viscosities, such as CB 100, CB 102 and ME902, are filled and heated under different temperatures in four cycles. Filling speed, temperature, and viscosity are used as variables to determine the optimal material and process conditions.

Prior to filling, the wafers were surface treated with UV cleaning and ethanol wash to ensure better wettability of the pastes. The resistivity of a fully filled TSVs with the as-prepared 95 wt % CB 100 silver paste is measured using the probe station. Hence, this method of TSV filling using CB 100 conductive paste after the surface treatment of the wafers could be a suitable technique for dry filling applications. Furthermore, silver nanowires are mixed with polymethyl methacrylate (PMMA) and are filled in the TSVs to compare conductivity and filling ratio to the conductive paste filling method.

Word count: 333