단일 첨가제를 이용한 고종횡비 TSV의 코발트 전해증착에 관한 연구

A Study on the Cobalt Electrodeposition of High Aspect Ratio Through-Silicon-Via (TSV) with Single Additive

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초 록 : The 3D interconnect technologies have been appeared, as the density of Integrated Circuit (IC) devices increases. Through Silicon Via (TSV) process is an important technology in the 3D interconnect technologies. And the process is used to form a vertically electrical connection through silicon dies. This TSV process has some advantages that short length of interconnection, high interconnection density, low electrical resistance, and low power consumption. Because of these advantages, TSVs could improve the device performance higher.

The fabrication process of TSV has several steps such as TSV etching, insulator deposition, seed layer deposition, metallization, planarization, and assembly. Among them, TSV metallization (i.e. TSV filling) was core process in the fabrication process of TSV because TSV metallization determines the performance and reliability of the TSV interconnect . TSVs were commonly filled with metals by using the simple electrochemical deposition method. However, since the aspect ratio of TSVs was become a higher, it was easy to occur voids and copper filling of TSVs became more difficult. Using some additives like an accelerator, suppressor and leveler for the void-free filling of TSVs, deposition rate of bottom could be fast whereas deposition of side walls could be inhibited. The suppressor was adsorbed surface of via easily because of its higher molecular weight than the accelerator. However, for high aspect ratio TSV fillers, the growth of the top of via can be accelerated because the suppressor is replaced by an accelerator. The substitution of the accelerator and the suppressor caused the side wall growth and defect generation. The suppressor was used as Single additive electrodeposition of TSV to overcome the constraints. At the electrochemical deposition of high aspect ratio of TSVs, the suppressor as single additive could effectively suppress the growth of the top surface and the void-free bottom-up filling became possible.

Generally, copper was used to fill TSVs since its low resistivity could reduce the RC delay of the interconnection. However, because of the large Coefficients of Thermal Expansion (CTE) mismatch between silicon and copper, stress was induced to the silicon around the TSVs at the annealing process. The Keep Out Zone (KOZ), the stressed area in the silicon, could affect carrier mobility and could cause degradation of the device performance. Cobalt can be used as an alternative material because the CTE of cobalt was lower than that of copper. Therefore, using cobalt could reduce KOZ and improve device performance.

In this study, high-aspect ratio TSVs were filled with cobalt using the electrochemical deposition. And the filling performance was enhanced by using the suppressor as single additive. Electrochemical analysis explains the effect of suppressor in the cobalt filling bath and the effect of filling behavior at condition such as current type was investigated.