

Reduction of thermal expansion coefficient of electrodeposited copper for TSV

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1. Introduction

The electrodeposited copper TSV suffers from 450°C heat. This 450°C heat is caused by insulating layer formation for wiring after TSV filling. The TSV pops up and destroy wiring above the TSV. This is main weak point of via middle process.

F.X.Che observed and numerically simulated the TSV pop ups. The pop ups are caused by the mismatch of the thermal expansion coefficient of copper and silicon(1). N.Kumar reported that pre anneal is effective to reduce the TSV popups(2). Seven times pre anneal at 400°C is suggested by P.Garrou(3).

2. Experimental

Thermal expansion coefficients of electrodeposited copper have been measured by as follows. Coppers are electrodeposited on aluminum substrate pipes sputtered with gold and the aluminum pipes are dissolved in NaOH solution. Hence, copper foil pipes form(Fig.1). Thermal expansion coefficient of these copper pipes have been measured in cylindrical rod of TD5020SA (NETZSCH)(Fig.1).

3. Results

1. Figure 2 is the top view of TSV after annealing at 450°C. Marked pop up (Protrusion) is observed at the TSV top.

2. Figure 3 shows the relation between expansion length and annealing temperature. Without additive, the expansion length increase linearly with annealing temperature(Fig. 3(a)). The thermal expansion coefficient is constant. With the additive, however, the expansion length is always lower than (a) and marked reduction is observed after 170 °C (Fig.3(b)). The increase in expansion length is observed after 350 °C, which may be due to the gas evolution of additives(Fig.3, Arrow).

3. According to the N.Kumar and P.Garrou reports, TSV popups can be avoided with pre annealing. We have measured the expansion length after 7th annealing at 400 °C, however, almost no reduction in expansion length (Same as curve a in Fig.3). Electrodeposits have

been prepared without additive. This result indicates that with adding our additive, no TSV pop ups occur..

* Chemicals are available from Nittobo Medical Co.Ltd
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1. F.X.Che et al., P-1-13, 3DIC(2011).
2. N.Kumar et al., ECTC, P1384(2011)
3. <http://www.electroiq.com/articles/ap/2010/12/cu-protrusion-keep-out.html>

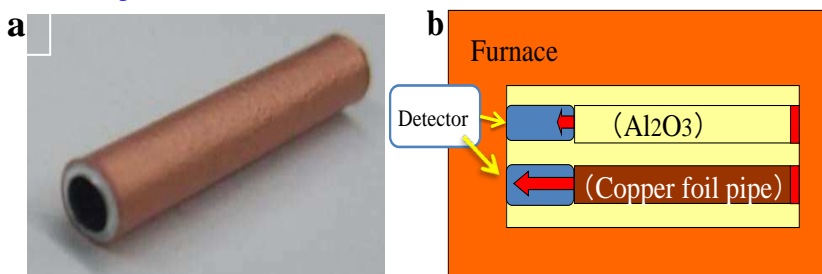


Fig.1 Copper foil pipe(a) and Schematic illustration of two cylindrical rods(b).

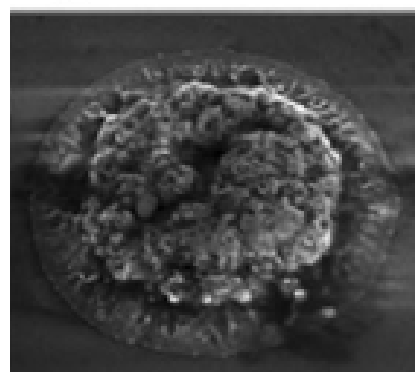


Fig.2 SEM top view of TSV.

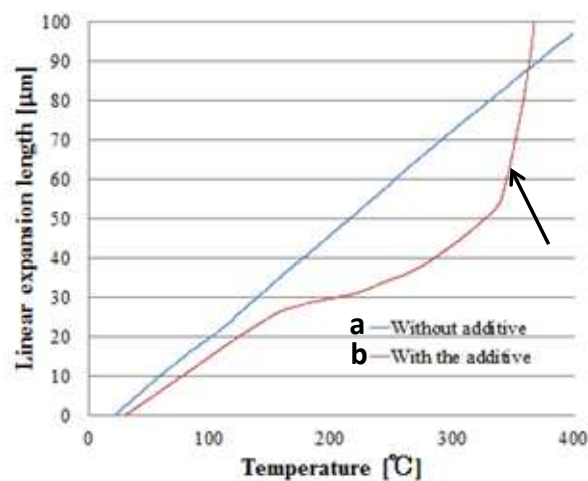


Fig.3 Relation between expansion length and annealing temperature.