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Fabrication of high thermal conductive diamond/copper composites and their joining with substrates

Cheng-Ying Lee, Yu-Siang Jhong, Yi-An Lai and Su-Jien Lin
National Tsing Hua University, Taiwan

Diamond/Cu composites for the use of heat spreader were fabricated via pressureless liquid phase sintering process. Minor addition of Zr was added into the matrix to improve the wettability between diamonds and Cu matrix. A high thermal conductivity of 716 W/m²K was obtained for the 50 vol% diamond/Cu composite. Composites fabricated by Cu/Zr flake method can reduce the surface roughness from 35 μm to 1.6 μm, which is suitable for joining with commercial substrates. AlN, Si, and Al₂O₃ substrates were joined with composites by commercial lead-free solder paste and liquid metal. Liquid metal joined packages had great performance opposite to the solder pasted ones with the highest thermal conductivity of 342 W/m²K in the couple of the Si substrate. For AlN, Si and Al₂O₃ substrate joined packages, average thermal conductivity were 299, 322 and 148 W/m²K, respectively. On the reliability of thermal cycle tests for joining packages, the lower thermal cycle (25-85OC) was to simulate the operating environment and the higher thermal cycle (25-200OC) for fabricating environment. It showed great reliability with above 78% residue thermal conductivity after lower temperature 1000 thermal cycles and 79% after higher temperature 5 thermal cycles.

irislee0606@gmail.com