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Direct Bonded Aluminum to Alumina Using a Transient Eutectic Liquid Phase for Power Electronics Applications

Authors : Yu-Ting Wang, Yun-Hsiang Cheng, Chien-Cheng Lin, Kun-Lin Lin

Abstract : Using a transient liquid phase method, Al was successfully bonded with Al_2O_3, which deposited Ni, Cu, Ge, and Si at the surface of the Al_2O_3 substrate after annealing at the relatively low melting point of Al. No reaction interlayer existed at the interface of any Al/Al_2O_3 specimens. Al−Fe intermetallic compounds, such as Al_9Fe_2 and Al_3Fe, formed in the Al substrate because of the precipitation of Fe, which was an impurity of the Al foil, and the reaction with Al at the grain boundaries of Al during annealing processing. According to the evaluation results of mechanical and thermal properties, the Al/Al_2O_3 specimen deposited on the Ni film possessed the highest shear strength, thermal conductivity, and bonding area percentage, followed by the Cu, Ge, and Si films. The properties of the Al/Al_2O_3 specimens deposited with Ge and Si were relatively unsatisfactory, which could be because the deposited amorphous layers easily formed oxide, resulting in inferior adhesion between Al and Al_2O_3. Therefore, the optimal choice for use in high-power devices is Al/Al_2O_3, with the deposition of Ni film.

Keywords : direct-bonded aluminum, transient liquid phase, thermal conductivity, microstructures, shear strength
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