

Abstract

A semiconductor device has a substrate and an electrical component disposed over the substrate. A heat spreader with a plasma-enhanced surface is disposed over the electrical component. A TIM is disposed between the electrical component and plasma-enhanced surface of the heat spreader. The TIM can be deposited on the electrical component or plasma-enhanced surface. The plasma-enhanced surface contains argon ions and oxygen ions. The heat spreader is disposed in a reaction chamber. Reactant gases, such as argon and oxygen, are introduced into the reaction chamber. An electric field is formed within the reaction chamber to ionize the argon and oxygen and form the plasma-enhanced surface. The plasma-enhanced surface has properties of roughness and tacky-ness or adhesive property by nature of the surface exhibiting a chemical bonding group. An underfill material is deposited between the electrical component and substrate. The electrical component can be a flipchip type semiconductor die.

(Fig. 2s)