

# Surface Engineering Approach for Diffusion Bonding of Pure Copper

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Diffusion bonding (DB) processes are typically performed in a vacuum furnace, which makes the process and equipment costly and results in a high cycle time. This study endeavours to perform diffusion bonding under non-vacuum conditions, yielding decreased cycle time and enhanced productivity. Surface modification prior to diffusion bonding to enhance the atomic diffusion flux and to rupture the oxide layer is an area of wide interest. Friction stir processing (FSP) is utilized as an economical surface modification technique to facilitate the diffusion bonding of copper in an argon atmosphere. FSP results in significant grain refinement and the accumulation of short-circuit defects, such as grain boundaries and dislocations. Diffusion bonding experiments were conducted by varying the bonding temperature and faying surface conditions. Grain growth of fine grains produced by FSP near the interface and grain boundary migration were observed to be the major mechanisms by which bonding has been achieved.

It is hypothesized that when clean metallic surfaces are brought into proximity at interatomic distances, bonding will happen. Single point diamond turning (SPDT) of Cu has resulted in the generation of nano-level surface roughness, brought the bonding surfaces in close contact, and enabled low-pressure bonding. The bonding ratio and shear strength were observed to increase with the rise in bonding temperature from 600°C to 800°C in accordance with the Arrhenius relationship. The precise alignment of the arrayed channels for conformal cooling applications can be accomplished using a combination of SPDT and SSDB, a task that would be difficult with alternative joining methods.

**Keywords:** Diffusion Bonding; FSP; SPDT; Surface modification, Microstructure evolution