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Mechanical and microstructural study of copper bonded at low temperature using Spark Plasma Sintering process

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Usually, a high purity copper diffusion bonding using a conventional furnace gives a bonding strength of 65 and 190 MPa using uniaxial tensile test for samples bonded respectively at 400 and 800°C with a holding pressure of 3.45 MPa for 60 min at top temperature following a 30 min ramp [1]. Furthermore, a room-temperature Cu/Cu direct bonding using surface activated bonding method (SAB) gives a bonding strength of 6.47 MPa under ultra High vacuum conditions [2].

In this study, bonding of high purity polished copper was investigated using the Spark Plasma Sintering technique (SPS) showing the effect of SPS parameters on the bonding strength and on the microstructural behaviour. Mechanical characterization of the bonded samples was performed at room temperature using tensile test, followed by microhardness study and grain size evolution. The bonding strength were found to be at 261MPa, 150 MPa and 170 MPa at holding temperature respectively of 200°C, 250°C and 300°C respectively with a 16 MPa holding pressure and a dwell time of 20min. The optimum value of the bonding strength, microhardness and grain size was found to be at only 200°C. The values decrease when SPS temperature increase to 250°C and they increase at 300°C due to evolution of mechanical properties of copper. This study firmly establishes the occurrence of recovery and recristallization during the bonding heat treatment leading to the evolution of the mechanical strength assembly.

Finally, we will show that the bonding strength of the samples assembled using SPS is close to the tensile strength of the bulk copper. To our knowledge, such results have not been reported yet.

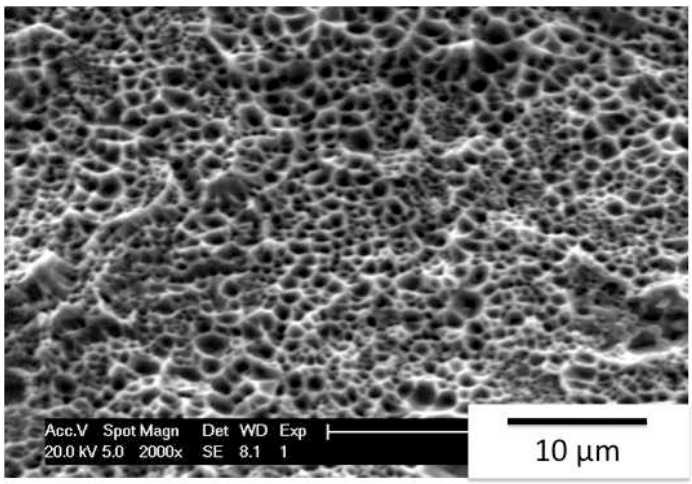


Figure 1: SEM image of the fracture surface (after tensile test) for a polished sample bonded at 300°C, for about 20 minutes holding time with a holding pressure of 16 MPa.

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