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Structural Analysis of Ceramic Substrates-DBC for Power Applications Using Local Approaches

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Direct Bonded Copper (DBC) substrates are a key component in power electronic devices, due to their ability to combine thermal, mechanical, and electrical properties in a single system. Usually made of ceramic materials such as aluminum oxide (Al2O3) or aluminum nitride (AlN), they offer high mechanical strength, electrical insulation and good thermal conductivity.
They are subjected to thermal cycling and significant mechanical stress. During operation, continuous heating and cooling cycles generate thermal stress between the copper and the ceramic layer due to significant differences in their thermal and mechanical properties. The difference in thermal expansion coefficients causes residual stresses to accumulate at interface surfaces, which, if not properly managed, compromise substrate integrity and lead to delamination, with critical consequences for the device.
For this reason, the development of innovative solutions, such as the introduction of optimized patterns or dimples to improve durability, has been essential.
Local approaches are a useful tool for analysing the stress fields that are generated in components that have notches. In the present study, the Notch Stress Intensity Factor (NSIF) was used to evaluate, with the same notch opening angle, the influence of the size and position of the dimple on the stress state near notch. Strain Energy Density (SED) was also used to assess how the combination of different geometric parameters, including the notch opening angle, affect the energy parameter.
These considerations constitute a preliminary study to be used as an optimization parameter, which could lead to the best geometrical configuration for DBC devices.

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