

Advancement in TPG Graphite Based Technology for Chip-level Thermal Management

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Abstract

Thermal management is an increasingly challenging problem in today's microelectronics industry, especially during the transition to GaN and SiC devices. As power requirement increases and available space decreases, innovative materials with high thermal conductivity (TC) and light weight are desired to remove the critical heat. Thermal Pyrolytic Graphite (TPG), a unique synthetic material produced by Momentive via chemical vapor deposition, contains millions of layers with highly-oriented stacked graphene planes and exhibits excellent in-plane thermal conductivity (>1500 W/m-K) and very low density (2.25 g/cm³). TPG composite using metal encapsulation, such as TC1050 heat spreader, TMP-EX heat sink, and TMP-FX thermal straps, simultaneously achieves high thermal conductivity from the TPG core and mechanical integrity from the metal shell. TMP-EX heat sink, with options of both high in-plane and through-plane thermal conduction, was developed particularly for chip-level thermal management. We would like to share with the community our studies in RF and LED applications which revealed 50~60% more power loadings was achieved with TMP-EX heat sinks. In addition, an integrated TPG-core insulated metal substrate (IMS) solution is being explored in a joint effort between Momentive and Henkel. Prototypes of single layer and multilayer IMS structures using TMP-EX as substrate material were produced and their thermal performance was demonstrated. The integration of TPG and IMS paves a new route for adding thermal loading, improving reliability, simplifying module design and reducing assembling cost/steps.