Method for Increasing Thermal Conductivity of a Substrate

Advantages

• Highly cost-effective and less complex processing techniques
• Novel process does not introduce defects into the substrate nor the thermal interface, and therefore enables the creation of nearly defect-free substrates
• Significantly enhances thermal conductivity, enabling the substrate to have higher packaging density, and therefore contributing to the construction of smaller electronic devices

Invention

Method and apparatus for enhancing thermal conductivity and heat dissipation of a substrate by forming a wide bandgap material within a non-wide bandgap substrate.

Background

In recent years, as electronic devices have become smaller, the packaging density for these devices on a circuit substrate has increased. Significant amounts of heat are produced by these electronic devices, making it necessary for the circuit substrate to radiate heat away efficiently. When mounting electronic devices in a high-density packaging configuration or producing modules containing power semiconductors, it is desirable to have a circuit substrate which has high thermal conductivity in addition to mechanical strength, and good electrical insulation. Various methods have been developed in order to achieve enhanced thermal conductivity on a substrate. In the prior art metallization methods, including dry-film imaging and screen printing, have been used for the production of conductive patterns on alumina. However, metal compatibility difficulties with high thermal conductivity ceramic materials such as aluminum nitride (AlN) and silicon carbide (SiC), have not yet been solved. The present invention provides solutions to this long-standing prior art problem, by introducing a direct laser synthesis of conductors within aluminum nitride (AlN), silicon carbide (SiC) and diamond substrates; moreover, forming a wide bandgap material within a non-wide bandgap substrate to enhance the thermal conductivity and heat dissipation of the substrate. One important property of semiconductor materials are their bandgap; i.e., the energy difference between the valence band of electrons and the conductance band. The size of the material’s bandgap provides fundamental limitations upon, or possibilities for, device structures and performances. Wide bandgap materials offer the potential for higher power capabilities (as compared to similar structures made from non-wide bandgap materials) as well as the potential for emitting light at higher frequencies. However, wide bandgap semiconductors materials are expensive due to high processing costs and poor yields emanating from wafer growth through device packaging. By forming a wide bandgap material within a non-wide bandgap substrate, this invention not only increases the thermal conductivity and heat dissipation of the substrate but also offers highly cost-effective and less complex processing techniques. In addition, it creates devices and circuitry that are compatible with selected ceramic substrates, while satisfying the need for higher temperature, aggressive environment, and higher density integrated circuit packing applications

Application

This novel invention can be applied to power supplies, communications apparatus, electronic warfare, multifunctional RF systems, and the power hybrid industry.

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