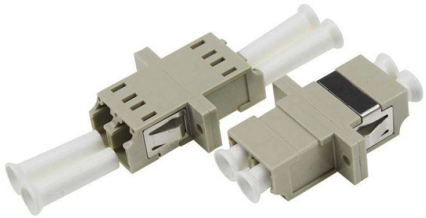
Ceramic substrate for optical module chips



Overview

In this paper, a novel multi-chip LED module with AlN-based ceramic substrate was successfully developed.

Key Takeaways

Aluminum nitride (AlN) ceramic substrates are the preferred choice for high-speed optical module chips due to their superior thermal conductivity, electrical insulation, and compatibility with photonic devices.Key Advantages of Ceramic Substrates

High Thermal Conductivity: AlN ceramic substrates typically offer thermal conductivity in the range of 170–230 W/m·K, significantly higher than traditional alumina (Al_2O_3) ceramics. This allows efficient heat dissipation from high-power components such as laser diodes, driver chips, and DSPs, reducing local temperature rise and improving module reliability . Electrical Insulation and Structural Support: AlN provides excellent electrical insulation while supporting the mechanical structure of optical modules. It enables electrical isolation, component mounting, and heat conduction simultaneously, meeting the multi-functional requirements of densely integrated optical modules . Thermal Expansion Matching: The thermal expansion coefficient of AlN closely matches that of silicon and indium phosphide (InP) chips, minimizing thermal stress during temperature cycling and enhancing long-term reliability . High-Frequency Performance: Ceramic substrates support stable signal transmission in high-speed optical communication systems, making them suitable for microwave, millimeter-wave, and optical transceivers .

Fabrication and Integration

Ceramic substrates for optical modules are often produced using High-Temperature Co-Fired Ceramic (HTCC) or Low-Temperature Co-Fired Ceramic (LTCC) processes. These methods allow the creation of multilayer substrates with through-holes, internal circuits, and polished surfaces suitable for thin-film metallization. This enables precise integration of photonic and electronic components . Customization: Substrate size, metallization patterns, and cavity shapes can be tailored to match specific optical module designs, including coherent optical sub-assemblies (COSA) and Si photonics devices .

Applications

AlN ceramic substrates are widely used in:

• High-speed optical transceivers (400G, 800G, 1.6T)

• Laser diode (LD) and electro-absorption modulator (EML) packaging

• Optical engines and photonic integrated circuits

• High-power, high-density optical modules Their combination of thermal management, electrical insulation, and mechanical stability makes them essential for next-generation optical communication systems .
Summary

For optical module chips, AlN ceramic substrates provide a reliable foundation that balances heat dissipation, electrical isolation, and structural support. They are increasingly favored over alumina in high-speed, high-power, and miniaturized optical modules, ensuring stable operation and long-term performance in advanced communication networks .

Article Content

Why AlN Ceramic Substrates Are Used in Optical Modules

Due to its excellent thermal conductivity and electrical insulation properties, aluminum nitride (AlN) ceramic substrates

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Enhance your optical communication systems with our high-performance Ceramic Substrates, specifically

AlN Ceramic Substrates: The Key to Stable, High-Speed Optical

Innovacera is dedicated to providing stable, reliable, and customizable aluminum nitride ceramic substrate solutions for

AlN Ceramic Substrate for Optical Modules | High Thermal Conductivity

An AlN ceramic optical module substrate is a high-performance ceramic component used for optical packaging applications,

Why AlN Ceramic Substrates Are Used in Optical Modules

In practical optical module designs, AlN ceramic substrates are primarily used to support and dissipate heat from laser

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Kyocera provides ceramic substrates and packages, fiber optic communication module components, optical fiber connection

AlN Ceramic Substrates: The Key to Stable, High-Speed Optical

High-performance aluminum nitride ceramic heat dissipation substrates are now crucial materials for high-end optical

Ceramic Substrates: The Core Material Revolution Powering AI

Ceramic substrates possess low dielectric constants and low dielectric loss characteristics, reducing signal attenuation and

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Kyocera proposes an LTCC substrate for optical communication devices that utilize Si photonics technology.

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Design and Fabrication of a Ceramic Substrate-Embedded SiC Power Module Abstract: Embedded packaging of wide-bandgap

Ceramic Substrates for Optical Communication Modules

Ceramic substrates for optical communication modules are critical components used in high-speed

Selecting the Right Substrate Materials for High Power Electronics

Among the choices for electronics and microelectronics for high-power applications are composite substrates composed of metals

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Ceramic Substrates for Optical Communication Modules | High

Ceramic substrates for optical communication modules are critical components used in high-speed photonic and optoelectronic

Big Changes Ahead For Interposers And Substrates

Interposers and substrates, once passive elements in packaging, now play an active role in dissipating heat to

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China Electronics Technology Group (CETC) – Manufactures ceramic and hybrid substrates for home-grown optical

Ceramic Packaging of IC Devices

Future development in ceramic packaging, which is driven by ad vances in chip technology, will require increased 1I0s, using either

Aluminum Nitride Substrates | 170-230 W/m·K

ADCERAX delivers aluminum nitride substrates engineered for stable thermal behavior, clean electrical

Thermal design and analysis of multi-chip LED module with ceramic substrate

In this paper, a novel multi-chip LED module with AlN-based ceramic substrate was successfully developed. Both

LTCC (Low Temperature Co-Fired Ceramics) Packages / Substrates

LTCC provides lower transmission loss compared to conventional alumina ceramics and is therefore used for packaging cutting-edge

Ceramic Packages, Submounts, and Lids for Optical Communications

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Ceramic Substrate Materials: The Ultimate Guide for High-Power ...

While semiconductor chips often receive the most attention, the performance and reliability of an electronic module frequently

Advanced Substrates for Chiplet and Heterogeneous Integration

In this chapter, the recent advances and trends in advanced substrates for high-performance computing (HPC) applications driven by

Aluminum Nitride Substrate

aluminum-nitride-ceramic-substrate-pieces The image shows aluminum nitride ceramic substrate pieces, known for their high thermal

VISHAY INTERTECHNOLOGY, INC. THIN FILM SUBSTRATES

Advanced thin film manufacturing capabilities have been developed by Vishay EFI to address custom substrate needs by bridging

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In early applications, aluminum oxide (Al2O3) ceramic substrates, thanks to their mature manufacturing processes

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Kyocera offers ceramic substrates for high-speed data applications (128G Baud), creating notches and cavity shapes to match your

AlN Ceramic Substrates: Enabling Stable Performance in Next

These balanced material properties make aluminum nitride ceramics an ideal foundation for high-value optical chips.

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