

Critical Materials for Power Module Packaging: Market Outlook, Supply Chain Risk & Technology Trends 2026-2036

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Abstracts

Power module packaging sits at the intersection of semiconductor performance and system-level reliability, forming the critical bridge between bare die and the thermal, electrical and mechanical demands of the end application. As silicon carbide and gallium nitride devices push junction temperatures beyond 175°C and switching frequencies into the megahertz range, the materials that surround, attach, interconnect and cool these chips have become the binding constraint on module performance. Raw materials and processed components — die attach pastes, ceramic substrates, encapsulants, baseplates, thermal interface materials and interconnects — together account for roughly a quarter of total packaging cost and a third of the finished module price, yet they receive a fraction of the attention devoted to the semiconductor devices themselves. This report addresses that gap.

The global power module packaging materials market is being reshaped by three converging forces. First, the rapid adoption of wide-bandgap semiconductors in electric vehicles, renewable energy inverters, industrial motor drives and data centre power supplies is creating sustained volume growth across every material category. SiC MOSFETs alone are expected to account for more than 30% of traction inverter shipments by 2030, each device demanding packaging materials capable of withstanding higher temperatures, greater thermomechanical stress and tighter parasitic inductance budgets than legacy silicon IGBTs. Second, geopolitical disruption and supply chain concentration are exposing critical vulnerabilities. Japan dominates the processing of ultra-high-purity copper powders, silver pastes, aluminium nitride and silicon nitride ceramics, and epoxy moulding compounds, while China is rapidly expanding domestic capacity across all of these segments. Silver price volatility — which spiked sharply in late 2025 and early 2026 — directly impacts die-attach costs, as silver

constitutes 20–22% of the raw material value in a typical power module. Copper accounts for a further 58%. Third, technology evolution is accelerating material substitution cycles. Die attach is migrating from conventional solder to silver sintering and, increasingly, to copper sintering for cost and conductivity advantages. Ceramic substrates are shifting from alumina DBC to aluminium nitride and silicon nitride AMB to survive the punishing power cycling requirements of automotive-qualified SiC modules. Interconnection is moving from aluminium wire bonds to copper ribbon and copper clip architectures that slash loop inductance to below 10 nH. Encapsulation is transitioning from standard epoxy moulding compounds to high-temperature silicone gels and advanced polymers that maintain dielectric integrity above 200°C.

The supply chain that delivers these materials spans from mining and primary smelting through to electronics-grade refining, powder processing, paste and preform formulation, component fabrication and, finally, module assembly. At each stage, value is added but so too is qualification risk. The bottleneck in most material families is not the availability of the raw ore or base chemical but the conversion into electronics-grade product — a step that demands extreme purity, tight particle size distributions and process know-how accumulated over decades. This creates oligopolistic structures at the mid-stream processing stage, where a handful of Japanese, German and American suppliers command dominant market shares. New entrants, particularly from China and South Korea, are investing heavily to close the gap, but automotive qualification cycles of two to five years mean that supply diversification will be gradual.

From a market sizing perspective, the packaging materials value chain for power modules is forecast to grow at a compound annual rate in the high single digits through 2036, driven primarily by electric vehicle penetration, grid-scale energy storage deployment and the electrification of industrial systems. The die attach segment — encompassing solder preforms, silver sintering pastes and emerging copper sintering materials — represents the fastest-growing category as silver sintering becomes the baseline technology for automotive SiC modules. Ceramic substrates, particularly silicon nitride AMB, are the highest-value component and the most supply-constrained. Encapsulation materials face a technology inflection as legacy epoxy moulding compounds reach their thermal limits and silicone-based alternatives gain traction. Baseplate materials are evolving from monolithic copper toward aluminium silicon carbide and copper-molybdenum composites that better match the coefficient of thermal expansion of the ceramic substrate above them, reducing solder joint fatigue and extending module lifetime.

This report provides a comprehensive, data-driven assessment of the entire packaging

materials value chain: from upstream mining and refining through mid-stream processing and formulation to downstream component manufacturing and module integration. It quantifies market size and growth by material type, application and region from 2021 to 2036, maps the supply chain with granular detail on regional concentration and qualification bottlenecks, assesses geopolitical and raw material price risk, and tracks the technology roadmap for each material family. With profiles of over 130 companies spanning raw material suppliers, component manufacturers, equipment vendors and power module OEMs, it is the most complete reference available for strategic planners, procurement teams, investors and technologists working across the power electronics value chain.

Critical Materials for Power Module Packaging: Market Outlook, Supply Chain Risk & Technology Trends 2026–2036 is the definitive market intelligence report on the materials, components and supply chains that underpin power module packaging for SiC, GaN and silicon devices. Covering die attach, ceramic substrates, encapsulation, interconnection, baseplates, thermal interface materials and their upstream raw materials, this report delivers ten-year market forecasts, supply chain mapping, geopolitical risk analysis, technology roadmaps and over 130 company profiles across the full value chain.

Report content includes:

Global market forecasts 2021–2036 for power module packaging materials by component type (die attach, ceramic substrate, encapsulation, interconnection, baseplate, TIM), by application (EV traction inverter, on-board charger, industrial drives, renewable energy, rail, data centre power) and by region

Detailed breakdown of raw material cost structures — copper (58% of value), silver (20–22%), aluminium, silicon, tin and specialty ceramics

Supply chain mapping from mining and primary smelting through electronics-grade refining, powder processing, paste/preform formulation, component fabrication and module assembly

Regional concentration analysis identifying critical single-source and oligopolistic bottlenecks in Japan, Germany, the United States and China

Geopolitical risk assessment covering export controls, tariff regimes, sanctions exposure and strategic stockpiling initiatives

Silver and copper price impact modelling on die attach, substrate metallisation and baseplate costs

Technology trend analysis and material substitution roadmaps for each packaging layer:

Die attach: solder ? Ag sintering ? Cu sintering

Substrates: Al₂O₃ DBC ? AlN AMB ? Si₃N₄ AMB

Interconnection: Al wire bond ? Cu ribbon ? Cu clip

Encapsulation: standard EMC ? high-temperature silicones/polymers

Baseplate: monolithic Cu ? AlSiC / CuMo composites

CTE mismatch analysis and thermomechanical reliability modelling across packaging stacks

M&A activity, joint ventures and strategic partnerships reshaping the supply landscape

Qualification timelines and barriers to entry for new material suppliers

Impact of SiC MOSFET adoption on packaging material specifications (junction temperature >175°C, low inductance)

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