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What if glass outperforms existing materials for advanced packaging substrates?



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1. Executive summary

Advanced semiconductor packages increasingly have to preserve signal quality, geometric precision and mechanical stability across larger, more densely interconnected structures. These requirements place new pressure on the substrate, which is no longer only a mechanical base. Its electrical, thermal and dimensional behavior can influence routing density, warpage, assembly and long-term reliability.

Glass can offer a distinctive combination of electrical insulation, smooth surfaces, high stiffness, controlled geometry and adjustable coefficients of thermal expansion within defined material limits. These properties can support fine redistribution layers, through-glass vias and larger substrate formats. The value of this combination, however, depends on the complete package. The glass composition, thickness and format must work with the dies, conductors, build-up materials, and interfaces.

This positions glass as an engineered material platform rather than a universal replacement for organic substrates, silicon or ceramics.

SCHOTT combines a broad specialty-glass portfolio with material data, precision formats and structured-glass capabilities to help development teams translate application requirements into an appropriate combination of glass composition and substrate geometry. This turns material selection into an additional design lever for advanced packaging.

The result is a criteria-based answer to the question of outperformance: glass creates the greatest value where its properties resolve several package constraints at once, not where a single parameter is optimized in isolation.

2. The substrate performance challenge

Advanced packaging brings logic, memory and specialized functions closer together, often within larger multi-die assemblies. As interconnects become finer and signal paths more demanding, the substrate must maintain electrical performance and geometric control through fabrication, assembly and operation. Requirements that could once be treated separately now interact: a change intended to reduce warpage may affect board-level stress, while a material selected for electrical performance may introduce different processing or thermal constraints.

Established substrate platforms address these requirements in different ways. Organic substrates benefit from mature supply chains, established build-up processes and broad design experience. Their thermomechanical and moisture-dependent behavior can become more difficult to manage as package dimensions grow and routing pitches tighten. Silicon provides exceptional precision and established semiconductor processing, but its conductive base requires electrical isolation, and its wafer-based format can constrain larger integration areas.

Ceramics offer strong thermal or high-frequency performance in selected applications, although their surface quality, feature capability and available formats depend heavily on the material and manufacturing route.[1]

Glass occupies a separate part of this design space. It combines electrical insulation with high stiffness, negligible moisture uptake, smooth surfaces and availability in wafer and panel formats. Its coefficient of thermal expansion can also be selected across different compositions. These characteristics create opportunities where electrical behavior, fine-feature processing and dimensional stability have to be achieved together. Glass nevertheless brings its own constraints, including brittleness, low thermal conductivity and a less mature substrate ecosystem than established organic platforms.

Criterion	Glass	Organic substrates	Silicon	Ceramics
Electrical behavior	Insulating with composition-dependent dielectric properties	Broad material range with mature build-up systems	Conductive base requires isolation	Often favorable for RF or high-frequency use
Dimensional control	High stiffness and negligible moisture uptake	More sensitive to moisture and thermomechanical change	Very high precision	High stability with process-dependent tolerances
Fine features	Fine RDL and TGV structures demonstrated	Advanced build-up processes with system-dependent scaling limits	Semiconductor-level precision	Capability depends on material and process
Format	Wafer and panel formats possible	Large formats established	Predominantly wafer based	Technology dependent
Main constraint	Brittleness, thermal conductivity and ecosystem maturity	Warpage and dimensional change at demanding scales	Cost, format and electrical isolation	Surface, format and processing limitations

Table 1. Material comparison for advanced packaging substrates

The relevant decision is therefore not which material wins every comparison, but which combination of properties addresses the limiting factors of a particular package. Glass becomes compelling when the architecture needs large-area precision, electrical insulation and adjustable thermomechanical behavior within the same material platform.