

Tailoring Photopolymer Chemistry for High-Performance Additive Manufacturing

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Additive manufacturing technologies have rapidly evolved in recent years, while the availability of materials capable of meeting demanding industrial requirements still represents a major challenge. Since the final performance of additively manufactured components strongly depends on material chemistry, the development of tailored formulations is a key step toward broader industrial adoption.

MAT3D develops advanced liquid photopolymer resins for additive manufacturing through an application-driven approach. Resin chemistry can be tailored to provide specific properties such as high mechanical performance, temperature and pressure resistance, thermal or electrical functionality, chemical resistance, flexibility, flame retardancy and improved sustainability. The development process combines formulation, material characterization and validation under relevant manufacturing conditions.

A representative example is **PEAKER**, a high-performance resin developed for rigid components and functional tooling. After thermal post-curing, PEAKER reaches a tensile modulus of **3.3 GPa**, a tensile strength of **67 MPa**, a flexural modulus of **4.5 GPa**, and a heat deflection temperature of up to **235 °C at 0.45 MPa**. Its glass transition temperature is approximately **135 °C**, while degradation occurs around **310 °C**. These properties enable its use in demanding applications including injection molding, compression molding and thermoforming, where additive manufacturing can reduce tooling time and cost while allowing greater geometrical freedom.

Alongside current industrial applications, MAT3D is investigating **vitrimers-based systems** as a route toward more reprocessable and sustainable thermoset materials. Current developments range from soft printable vitrimers to high-performance epoxy formulations and matrices for composite manufacturing.

The presentation will provide an overview of MAT3D's material-development strategy, selected industrial applications and ongoing research toward high-performance and more sustainable materials for additive manufacturing.

INJECTION MOLDING



COMPRESSION MOLDING



THERMOFORMATION



Figure 1: Examples of MAT3D resins applied to tooling for different manufacturing processes. PEAKER is used for high-performance tooling in injection molding and thermoforming, where temperature and pressure resistance are required. HARDWEAR is shown in the central example for compression molding, exploiting its flexibility and abrasion resistance. The figure illustrates how different resin formulations can be tailored to the specific requirements of each manufacturing process.