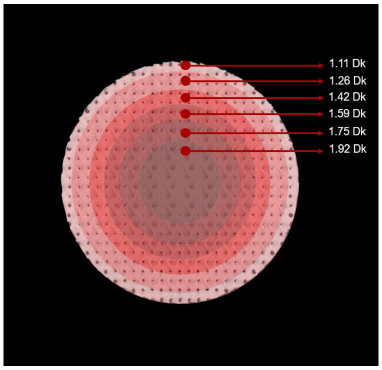
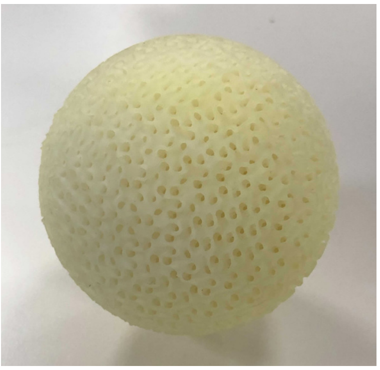
LOW LOSS DIELECTRIC 3D PRINTING

NEW 3D PRINTING MATERIALS FOR RF APPLICATIONS

Fortify brings to market a palette of low-loss dielectric materials for printing components and devices used in wide bandwidth, high frequency communication and sensing systems. Specifically tailored for microwave and mmWave applications, the Fortify 3D printing platform grants users the capability to manufacture low roughness, high-resolution features necessary for high frequency devices.

(Right) 3D-printed Luneburg-style gradient dielectric lens fabricated with the Low Loss 2.6 dielectric polymer. The cross section view of the lens (left) shows the radially symmetric density gradient. Denser regions of the lens result in higher effective permittivity, where the more sparse regions have a lower effective permittivity.





FORTIFY DIGITAL COMPOSITE MANUFACTURING

Fortify's advanced Digital Composite Manufacturing (DCM) processing technology grants customers the ability to efficiently design and print precision substrates, Luneburg-like **Gradient Refractive Index (GRIN)** lenses, and end-use components. The powered DLP printing platform enables high-throughput production of fine-featured parts from heavily loaded materials that are otherwise difficult to process. The Low Loss 2.6 and Low Loss 4.9 materials consist of a unique low-loss polymer blended with specialty dielectric ceramic additives to create these high performance dielectric materials. The Continuous Kinetic Mixing (CKM™) module circulates, heats, and mixes the loaded materials to maintain particle suspension and ensure even dispersion throughout the printing process.

Leveraging lattice-based design, the Fortify platform can print functionally graded architectures - generating monolithic components with smooth gradients of effective permittivity perfect for **GRIN** applications. These low loss materials are an excellent choice for printing lenses, wave-guides, connectors, and substrates.

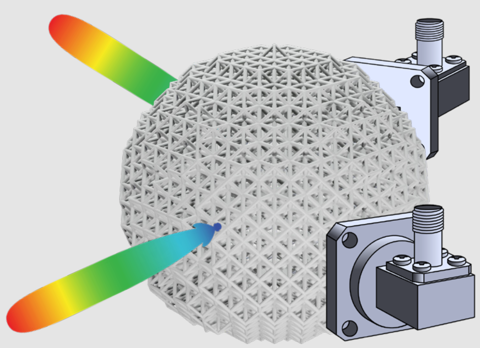
MATERIAL PROPERTIES

*	Low Loss 2.6	Low Loss 4.9
Dielectric Constant (SPDR @ 10GHz)	2.6	4.9
Dielectric Loss Tangent (SPDR @ 10GHz)	0.0049	0.0039
CTE (TMA, xy-dir and z-dir, -50 to 50C)	83ppm/C	<80ppm/C
Water Absorption (wt% gain; 24hr @ 50C)	<0.1%	<0.1%
Decomposition Temperature (TGA 1% wt loss)	>280 °C	>280 °C
Outgassing (ASTM E595, vacuum; TML < 1.0% CVCM <0.10%)	Pass	Pass

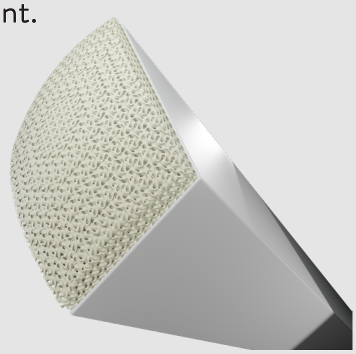
*PRELIMINARY DATA

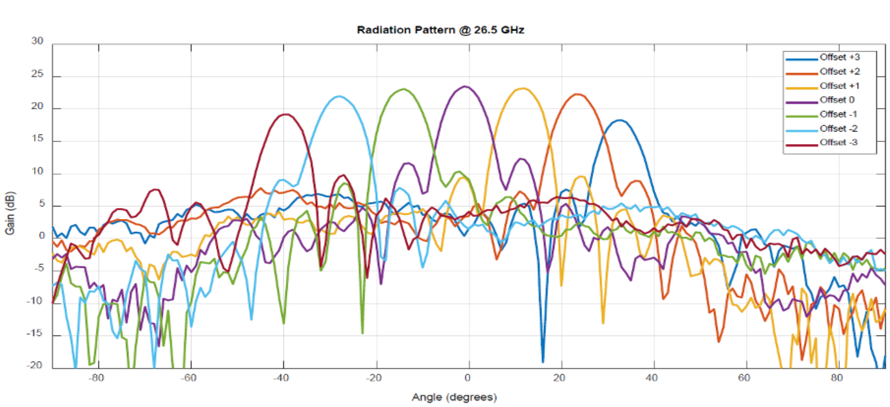
SAMPLE APPLICATIONS

Passive mmWave Beamforming and Beam Switching antennas are straightforward to design and implement with radially symmetric Luneburg-style lenses printed from the Low Loss 2.6 material. Multiple feeds can be placed anywhere along the surface of a lens to create a beam switching device for lower-complexity steering systems.



Dielectric GRIN lenses can be used to augment performance of standard gain horn antennas. Mounting a lens to a horn can increase directivity and gain, collimate the wavefront, or convert a diverging wavefront into a converging, spot focusing signal. Customers often pair 3D printed lenses with horn antennas when high gain is required in minimum space, or to rapidly modify the performance characteristics of existing equipment.





Radiation pattern for a 1.3 Dk to 1.7 Dk 3D-printed spherical Luneburg-style lens was tested at 26.5 GHz. A waveguide feed source was linearly translated on the backside of the lens to feed the lens from different positions ("offset 0" is at boresight). The peak gain for each feed position was captured in the azimuth plane to determine which direction the beam was pointing. For this experiment, the beam gain predictably drops for wider scan angles as the lens aperture shrinks relative to the feed position.

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