FORTIFY

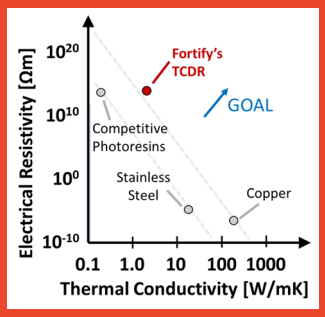
THERMALLY CONDUCTIVE 3D PRINTING

HIGH RESOLUTION PARTS THAT CONDUCT HEAT, NOT ELECTRICITY

Fortify is excited to introduce TCDR (Thermally Conductive Dielectric Resin), a material designed for thermal management applications that require electrical insulation. (TCDR) has a thermal conductivity of up 2 W/mK while maintaining impressive dielectric strengths over 27 kV/mm.

The material exhibits good strength and resolution characteristics and can be used to print accurate and watertight parts.

A 3D printed heat sink from Fortify's Thermally Conductive Dielectric Resin (TCDR) that exhibits impressive cooling power.



TCDR offers exciting levels of thermal conductivity while maintaining very high electrical resistivities required in many applications.

FORTIFY'S FLUX DEVELOPER PLATFORM

Fortify's TCDR was created using the Flux Developer platform that accelerates time to market for new materials formulations. TCDR is a highly filled photo-resin that can be printed on Fortify systems including the FLUX CORE printer. FLUX CORE is a DLP printing platform that enables high-throughput production of fine-featured parts from heavily loaded materials that are otherwise difficult to process. FLUX CORE comes with the Continuous Kinetic Mixing (CKM™) module that circulates, heats, and mixes loaded materials to maintain particle suspension and ensure even dispersion throughout the printing process.

MATERIAL PROPERTIES

PHYSICAL PROPERTY	TCDR	TEST METHOD
Thermal Conductivity XY axis (W/mK)	1.8-2.1	ASTM E1461
Thermal Conductivity Z axis (W/mK)	0.7-0.8	ASTM E1461
Electrical Resistivity (Ω·cm)	10^{16}	ASTM D257
Dielectric Strength (kV/mm)	30	ASTM D149
Young's Modulus (GPa)	6.4	ASTM D638

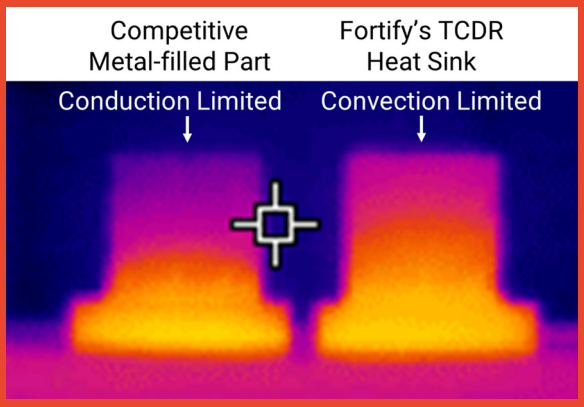
SAMPLE APPLICATIONS

TCDR brings thermal management solutions to many applications including the following use cases:

Heat sinks are used in high density power electronics in concert with convective cooling. TCDR-based heat sinks enable for direct contact with hot electrical surfaces, generative design to optimize performance, and compatibility in and around RF devices that don't tolerate metallic elements.

Cold plates are used in data centers, electric vehicles, and power electronics. TCDR-based cold plates offer several advantages over incumbent metal solutions including lower weight, resistance to corrosion and fouling, electrical insulation, and the ability to produce complex geometries that provide higher performance.

Heat exchangers are used in data centers, aerospace, and automotive markets. TCDR-based heat exchangers are lighter than metal, compatible with more coolants than current copper or stainless steel products, and offer design flexibility to achieve higher cooling efficiency than conventional designs.



A forward-looking infrared (FLIR) camera takes an in-situ image of a high resolution TCDR heat sink relative to a competitive comparable metal-filled part. Within the metal-filled part, heat builds up near the lower hot surface due to a lower thermal conductivity. Instead, the heat sink made from Fortify's TCDR effectively moves heat through the heat sink and shows signs of being convection limited suggesting further increases in thermal conductivity wouldn't bring much value.

HOW IT WORKS

Achieving thermal conductivity without also conducting electricity is a challenging task. Fortify's material science team leveraged specially selected crystalline ceramics that transport heat through coordinated atomic vibrations (phonons) instead of through electron transport which also creates electrical conduction. Combining phononic-crystals at high filler amounts create a percolated network within the resin that allows the impressive outcome.