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HIGH-PERFORMANCE MATERIAL SOLUTIONS FOR HIGH SPEED CONNECTOR

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INTRODUCTION

With deployment of the 5G network, larger quantities of data processing at greater speeds are becoming increasingly important. This new trend has increased the demand for handling a much larger quantity of data through smaller wired and wireless devices at higher speeds. This kind of demand drives connector manufacturers to develop new high-speed connectors that enable faster data transmission speed from 56Gbps to 112Gbps and later 224Gbps or faster. With every stepwise speed improvement, there are many challenges which might trigger use of optical connections instead of copper. To enable high quality and higher speed data transfer, components used in electronic transmission lines, especially connectors, must be carefully designed for minimizing signal loss/decay and interference. In response to this new trend, Celanese introduced tunable dielectric constant (Dk) / dissipation factor (Df) Zenite® Liquid Crystal Polymer (LCP) for high-speed connectors.

High-speed connector performance is determined by the capability of the connection for data transfer with high signal integrity over a wide range of signal frequencies. Since the connector is part of a large transmission line network, it should be transparent to signal propagation, which is critical for enabling faster data transfer without compromising signal integrity. The transparency of connector to signal propagation can often be affected by cross-talk between pitches and impedance mismatch between connector and transmission line, which creates signal loss/decay. Thus, efforts to minimize cross-talk and impedance mismatch in fine pitch high-speed connectors increases the demand for dielectric materials. In addition, the dielectric materials must meet requirements for conventional connectors, such as mechanical robustness, good processability in injection molding and high heat resistance for soldering.

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NEW THERMOPLASTICS FOR FASTER DATA TRANSMISSION SPEED

As one of the world's leading manufacturers of high-performance engineering thermoplastics, Celanese has extensive experience in providing a variety of solutions across many markets to improve daily life. We now offer innovative solutions to create a reliable network connection with faster data transfer.

Within our broad material portfolio, Celanese offers Vectra® and Zenite® Liquid Crystal Polymers (LCP), which are injection moldable, aromatic thermoplastic polymers featuring high flow (enabling production of very thin parts), extremely low moisture absorption, low coefficient of linear thermal expansion (CLTE), high heat resistance, inherent flame retardancy, high resistance to stress cracking and chemical inertness.

Especially important for high speed telecommunication applications, Our Vectra® and Zenite® LCP resins offer higher Dk (Zenite® LCP 55205) and/or lower Df (Vectra® LCP S475) than rival LCPs and other aromatic thermoplastics, such as polyphenylene sulfide (PPS) [*Table 1*]. These products have been widely used in high-speed connectors for many years, but recent 5G deployment pushes the limit further, requiring even better solutions.

To meet the new requirements, Vectra® and Zenite® LCP product offerings have been extended to include a new tailored Dk/Df Zenite® LCP portfolio, specifically designed for high- speed connectors. Celanese is able to tailor Dk/Df values in LCPs, not only through the use of LCP polymer technology, but also through proprietary fillers and specialty compounding. These capabilities allow us to provide a product that meets a customer's exact Dk/Df target.

Zenite® LCP 650 (Dk/Df = 12/0.008), one of high Dk Zenite® LCPs, has recently been commercialized for high-speed connectors. In addition to this grade, Zenite® LCP 550 (Zenite® LCP LKX1775, Dk/Df = 9/0.007), Zenite® LCP 760 (LKX1778, Dk/Df = 15/0.018), Zenite® LCP 770 (Zenite® LCP LKX1792, Dk/Df = 18/0.029) and Zenite® LCP 870 (Zenite® LCP LKX1793, Dk/Df = 22/0.03) are available for customer sampling. (The Dk/Df value is determined via the IEC 61189-2-721 method [*Table 1 and Figure 1*]). High Dk Zenite® LCPs are formulated specifically for connectors requiring impedance matching for improved signal integrity, which enables high-speed data transmission. Celanese can tailor the Dk/Df value in LCPs, making it possible to have a material with a Dk in the range of 4 – 25 at 2 GHz, while maintaining the Df value as low as possible [*Figure 1*]. This capability allows customers to quickly achieve optimum impedance matching and accelerates customer projects.

In addition, these grades stand out from other products in the market with a consistent Dk/Df value in harsh conditions (e.g., variations across the temperature range -40°C to +100°C over a test period of 1000 h) without compromising mechanical strength. All high Dk Zenite® LCPs offer high heat resistance (Heat Deflection Temperature, HDT, under 1.8MPa load, is greater than 260°C (ISO 75-1)).

Zenite® LCP 251, one of low Dk Zenite® LCPs, was developed for high-speed connectors, requiring lower Dk and lower Df (*Table 1 and Figure 2*). This grade has a very low and consistent Dk (~3.0 at 10GHz) and Df (0.003 at 10 GHz) across a wide range of temperatures and electronic frequencies. Low Dk/Df LCP avoids

Grade name	Dk*at 2 GHz	Df*at 2 GHz
Zenite® LCP 251	3	0.003
Zenite® LCP 5115L	3.7	0.003
Vectra® LCP S475	3.9	0.0015
Zenite® LCP 55205	6.2	0.004
Zenite® LCP 550 (Zenite® LCP LKX1775)	9	0.007
Zenite® LCP 650	12	0.008
Zenite® LCP 760 (Zenite® LCP LKX1778)	15	0.018
Zenite® LCP 770 (Zenite® LCP LKX1792)	18	0.029
Zenite® LCP 870 (Zenite® LCP LKX1793)	22	0.034

*measured via IEC 61189-2-721

Table 1. promotable tunable Dk/Df Zenite® LCPs

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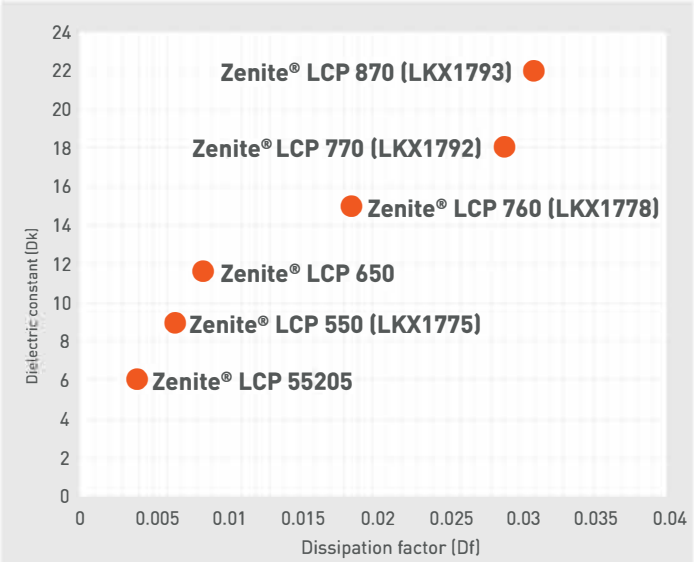


Figure 1. *Dk/Df values for high Dk Zenite® LCPs, measured via IEC 61189-2-721 method at 2 GHz.*

cross-talk and improves signal integrity for high-speed data transmission. It has low moisture absorption (~0.02% in high humidity, determined via ISO 62) and high heat resistance (Heat Deflection Temperature, HDT, under 1.8MPa load, is 290°C [ISO 75-1]). Zenite® LCP 251 is a wholly aromatic LCP. Its crystal structure remains intact during the phase transition from melt to solid. As a result, the phase transition takes an extremely small amount of enthalpy. This also explains why the Coefficient of Linear Thermal Expansion, CLTE, of an LCP (as measured according to ISO 11359-2) is very low - in the same range as metals and ceramics.
Another benefit of this new grade is its high flow, even in parts with very thin walls (~0.2 mm thickness). This is due to its excellent shear thinning effect,

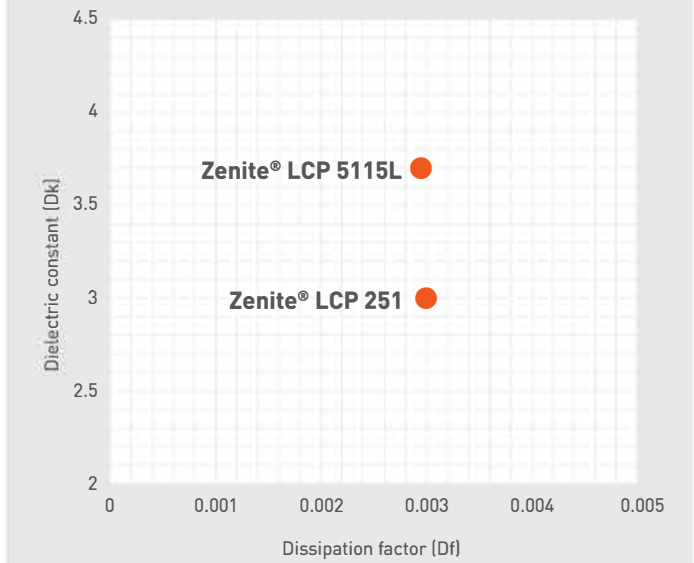


Figure 2. *Dk/Df values for low Dk Zenite® LCPs, measured via IEC 61189-2-721 method at 2 GHz.*

which is higher than in other LCPs. This high flow capability allows more freedom in part design, making it possible, for instance, to create slim, fine-pitch connectors with thin walls.

CONCLUSION

In order to meet faster/larger data processing needs, connector manufacturers often deal with technical challenges during the development of connectors with significantly faster data transmission speed. The market is pushing for miniaturization of connectors with a higher number of pins. To meet needs of connector manufacturers, Celanese has developed a series of tunable Dk/Df Zenite® LCP, specifically designed for high-speed connectors, including back plane and automotive connectors.
High Dk Zenite® LCP is a perfect solution for high-speed connectors, requiring impedance matching. Tunable Dk/Df capability allows customers to find optimum impedance matching quickly and accelerate customer projects. Low Dk Zenite® LCP is developed specifically for high-speed connectors, requiring minimization of cross-talk for improved signal integrity. Consistent Dk/Df in harsh conditions, high strength and high heat resistance without compromising material flowability are strengths of the tunable Dk/Df Zenite® LCP.
Celanese has been a solution provider for industries using engineered materials for decades. The newly launched a series of tailored Dk/Df Zenite® LCP portfolio will have a significant impact on the growing need for high-speed data transmission in the world of Connectivity.

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