FOR IMMEDIATE RELEASE: 11 May 2019
PR # SCAT-01-19

LIQUID CRYSTAL POLYMERS MATERIAL OF CHOICE FOR FINE-PITCH ELECTRICAL CONNECTORS

Two New, High-Flow, Low-Warpage Formulations Key to Achieving Today's Thinner, Smaller, Higher-Density Interconnects

Phoenix, Ariz., U.S. — Today, liquid crystal (or crystalline) polymers (LCPs) are widely used in the electronics industry for a variety of surface-mount technology (SMT), including connectors — for example, small-outline, dual inline memory modules (S/O DIMMs) for laptop computers and flexible printed circuits (FPCs) for smartphones and tablet computers — because these resins provide excellent flow to fill complex geometries in short cycle times, exceptional thermal and chemical resistance, unique mechanical properties, they achieve UL* 94 V-0 flame retardance without needing flame retardant additives, and offal/scrap can be recycled (melt reprocessed). In a growing number of cases, LCPs also are being selected to mold very-demanding fine-pitch connectors, which are smaller, thinner, and designed to be stacked higher than traditional connectors in order to save real estate (space) on printed-circuit boards (PCBs) to meet miniaturization trends for smaller, more compact consumer electronics. To support this trend, Sumitomo Chemical Advanced Technologies LLC (here) has developed two new SumikaSuper™ LCP grades specifically designed to meet the challenging requirements of fine-pitch connectors.

Fine-pitch connectors are a newer type of interconnect useful in PCB designs where space is limited and small centerline or pitch spacing makes larger wire-to-board interconnects impractical. They tend to provide ultra-fine pitch spacing (0.2 to 0.3 mm), are smaller and thinner than traditional connectors, and are optimized for lower profile stack heights (down to 1 mm) but higher stacking density than conventional connectors. Additionally, these high-density connectors must be rugged, reliable, and affordable, must provide high thermal and chemical resistance to survive surface-mount processing conditions as well as to operate in compact devices with less space to dissipate heat. The new SumikaSuper LCP grades for fine-pitch connectors offer excellent processability and low warpage in very-thin wall sections to accurately mold the thin, light, small interconnects and through holes.

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In the world of plastics, LCPs are a family of polymers that produce thermoplastic parts with unique processing characteristics and extremely high performance. Most commercial LCPs are aromatic polyesters that are characterized by high thermal and mechanical performance, inherent flame retardancy, good weatherability, excellent electrical properties[1], high resistance to stress cracking, and chemical inertness.[2] This makes them ideal for use in electrical and electronic components (including fiberoptic cables, PCBs, chip carriers and other surface-mount components, microelectromechanical systems (MEMS), automotive applications (including components for ignition and transmission systems, lamp sockets, pump components, coil forms, and sensors), printer/copier/fax components, cookware, high-barrier/retort-processed food containers, plus components for chemical processing (including pumps, meters, and valves).

LCPs are most commonly processed via injection molding, although other techniques such as fiber spinning, extrusion, coating, and sheet and film products have been used. They are amendable to a variety of thermoplastic welding techniques, particularly ultrasonic and laser welding. Owing to the highly rigid structure of their molecular chains and their liquid crystalline nature — which tend to be nearly linear and to occupy a stacked orientation that maintains its order regardless of solid or liquid phase — LCPs are highly anisotropic. Essentially, primary bonds *within* an LCP polymer chain are highly attractive and hard to break, while secondary bonds *between* molecular chains are weaker and much easier to break. Although most thermoplastics and especially fiber-reinforced thermoplastics exhibit some degree of anisotropy after processing, the molded properties of LCPs can be significantly different in flow and cross-flow directions[3], which requires some care when designing parts with and tools for these polymers to take advantage of (and avoid the challenges of) this characteristic. The highly ordered and linear nature of these molecular chains provides LCPs with self-reinforcing properties in the flow direction and contribute to excellent mechanical properties.

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[1] Electrical properties include high electrical resistivity, low relative dielectric constant, and low dissipation factor.
[2] Resistance is excellent to strong and weak acids, alcohols, esters, ketones, and aromatic, chlorinated, and halogenated hydrocarbons over a broad range of temperatures. Hydrolytic stability in boiling water also is excellent. LCPs can be attacked by high-temperature steam, concentrated sulfuric acid, and boiling caustic chemicals. A more comprehensive treatment of the chemical resistance of LCPs is shown in Table 1 at **https://www.sumitomo-chem.co.jp/sep/english/products/lcp/lcp_bs_kagaku.html**.
[3] It has been reported in the literature that anisotropic-dependent properties (e.g. tensile strength, coefficient of linear thermal expansion (CLTE), and elastic modulus) can be up to 3x greater in the flow vs. cross-flow direction. LCPs also have a high Z-axis CLTE.

Like any material, LCPs have their disadvantages, although these issues can generally be overcome. For example, the high anisotropy found in LCPs means that weldlines (where flow fronts with different molecular orientations converge) are weaker and thus prone to warpage and thermal-expansion differentials. In fact, LCPs are typically reinforced with glass fiber and mineral fillers — not so much to increase stiffness and strength but to reduce anisotropy. Warpage can be ameliorated through proper gate design in the injection molding tool. Because of their high performance, LCPs are priced accordingly. However, given their high melt flow rates, fast setup times, and low thermal expansion in the direction of flow, LCPs can be formed into thin-wall parts with short molding cycles that deliver high performance at low mass and lower material usage — all of which help offset higher initial material costs. (They also can be molded into large, thick-walled parts too.) The thermal stability typical of LCPs enables processors to efficiently reuse regrind and recycle reject parts, which again reduces material losses and lowers effective part cost. Hence, LCPs are commonly used to replace metals, ceramics, and other plastics due to high thermal resistance, excellent flowability, and opportunities for weight or wallstock reductions.

In the case of fine-pitch connectors, the two new grades — SumikaSuper SZ6505HF, which provides higher flow for parts with thicknesses at or above 0.10 mm, and SumikaSuper SR2506, which provides higher flow for parts with thicknesses at or below 0.08 mm — provide a number of benefits vs. standard grades of LCPs in the same chemistry. For example, they exhibit improved injection molding processability in thin walls (injection pressure vs. filling ratio, flow length vs. thickness, and temperature vs. viscosity. In fact, both new grades are said to have set new standards for flowability and processability vs. polyester-based LCPs in the global market. They also are less prone to warpage in thin walls than standard grades of LCP.

Sumitomo Chemical can offer a suitable LCP grade depending on the design and thickness requirements of a given connector. The company has been producing polyester-based LPCs since 1972 and provides dozens of compounds as well as alloys with other high-performance thermoplastics like polyethersulfone (PES) to meet a wide range of mechanical and thermal requirements (from 260 to 360°C). In addition to high-quality material, the company also is known for its first-class technical support — from part design to on-site molding assistance.

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Sumitomo Chemical Advanced Technologies LLC, formerly called Sumika Electronic Materials and a wholly owned subsidiary of Sumitomo Chemical Co., Ltd., is a leading manufacturer of liquid crystal polymer (LCP), polyethersulfone (PES), and high-performance alloy resins. The company serves as the U.S. base of operations and customer support for Sumitomo Chemical's photoresist and engineering plastics businesses and is certified to ISO9001:2008 and ISO14001:2004 standards. For more information, see http://www.sumikamaterials.com/ or call +1.602.659.2500.

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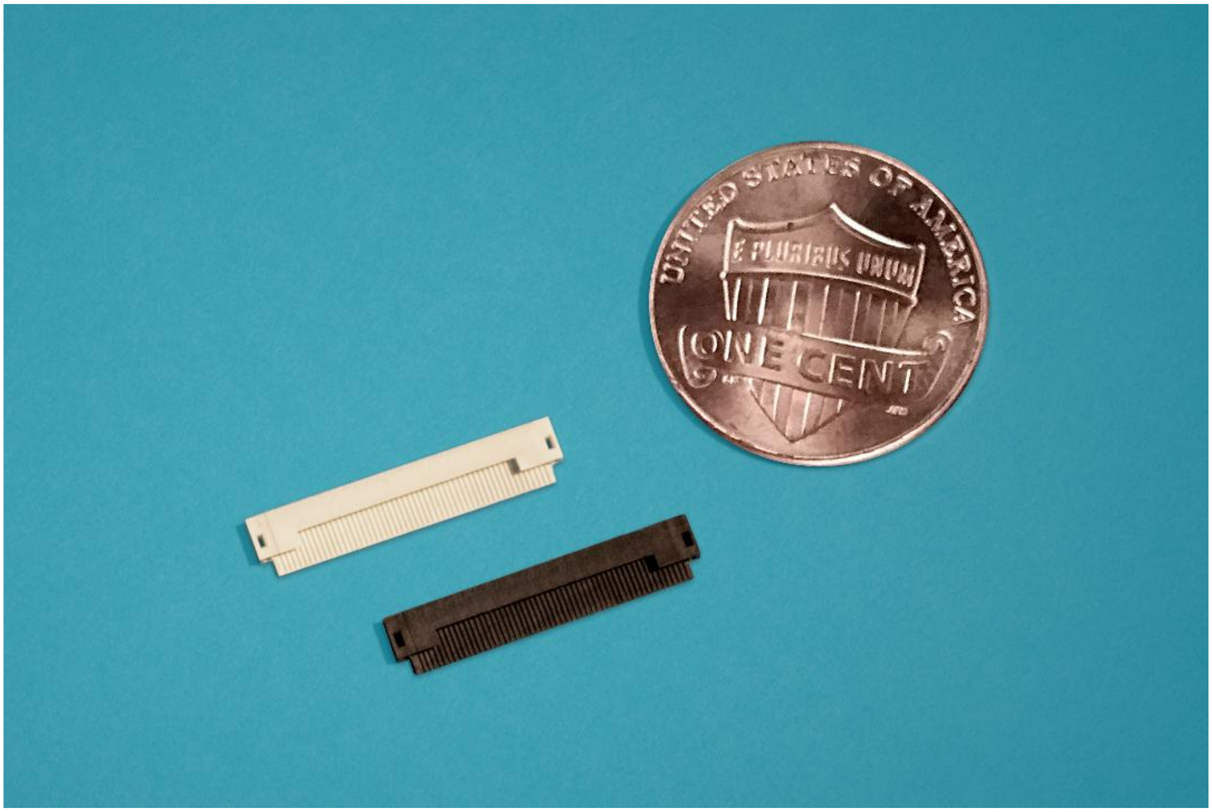

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Phoenix, Ariz., U.S. — Liquid crystal (or crystalline) polymers (LCPs) are widely used in the electronics industry for a variety of surface-mount technology (SMT) because these resins provide excellent flow to fill complex geometries in short cycle times, exceptional thermal and chemical resistance, unique mechanical properties, they achieve UL* 94 V-0 flame retardance without needing flame retardant additives, and offal/scrap can be melt reprocessed. In a growing number of cases, LCPs also are being selected to mold very-demanding fine-pitch connectors, which are smaller, thinner, and designed to be stacked higher than traditional connectors in order to save real estate (space) on printed-circuit boards (PCBs) to meet miniaturization trends for smaller, more compact consumer electronics. To support this trend, Sumitomo Chemical Advanced Technologies LLC (here) has developed two new SumikaSuper™ LCP grades specifically designed to meet the challenging requirements of fine-pitch connectors.

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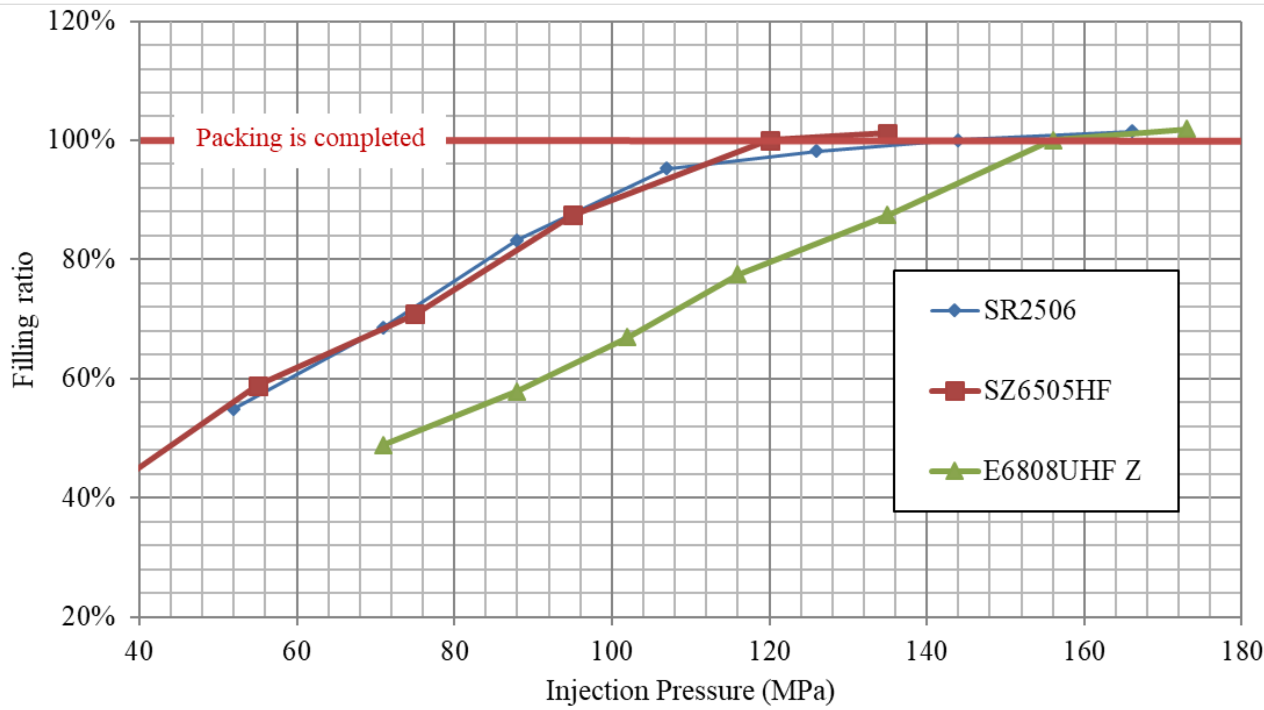

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Injection pressure vs. filling ratio are compared for two new grades of fiberglass- and mineral-filled LCPs specifically designed for use in fine-pitch connectors (SumikaSuper™ SR2506 (blue line) and SZ6505HF (red line)) vs. a standard grade (SumikaSuper E6808UHF Z LCP (green line)). The data show that both new grades fill the test part faster and more easily (at lower pressures) than the standard grade.

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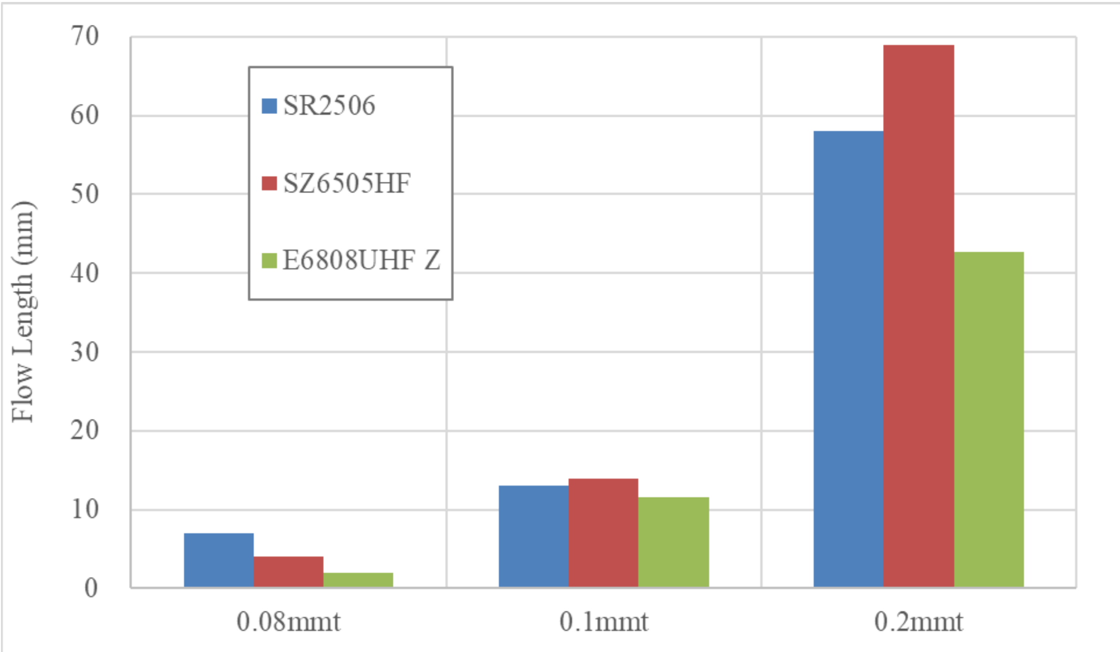

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Results of tests measuring flow length vs. thickness (in mm (also called MMT)) for two new LCP grades (SumikaSuper™ SR2506 (blue bars) and SumikaSuper SZ6505HF (red bars)) vs. a standard grade (SumikaSuper E6808UHF Z (green bars)) showed that SumikaSuper SZ6505HF (red bars) demonstrated the best flowability down to 0.1 mm among commercially available LCPs. Below 0.1 mm, SumikaSuper SR2506 (blue bars) offers the best performance thanks to successful control of melt-viscosity vs. temperature dependency. In that grade, melt viscosity is less temperature sensitive, which is why it flows better than other LCPs in extremely thin wall sections — considered a severe molding condition. Both new grades are said to have set new standards for flowability and processability for LCPs in the global market.

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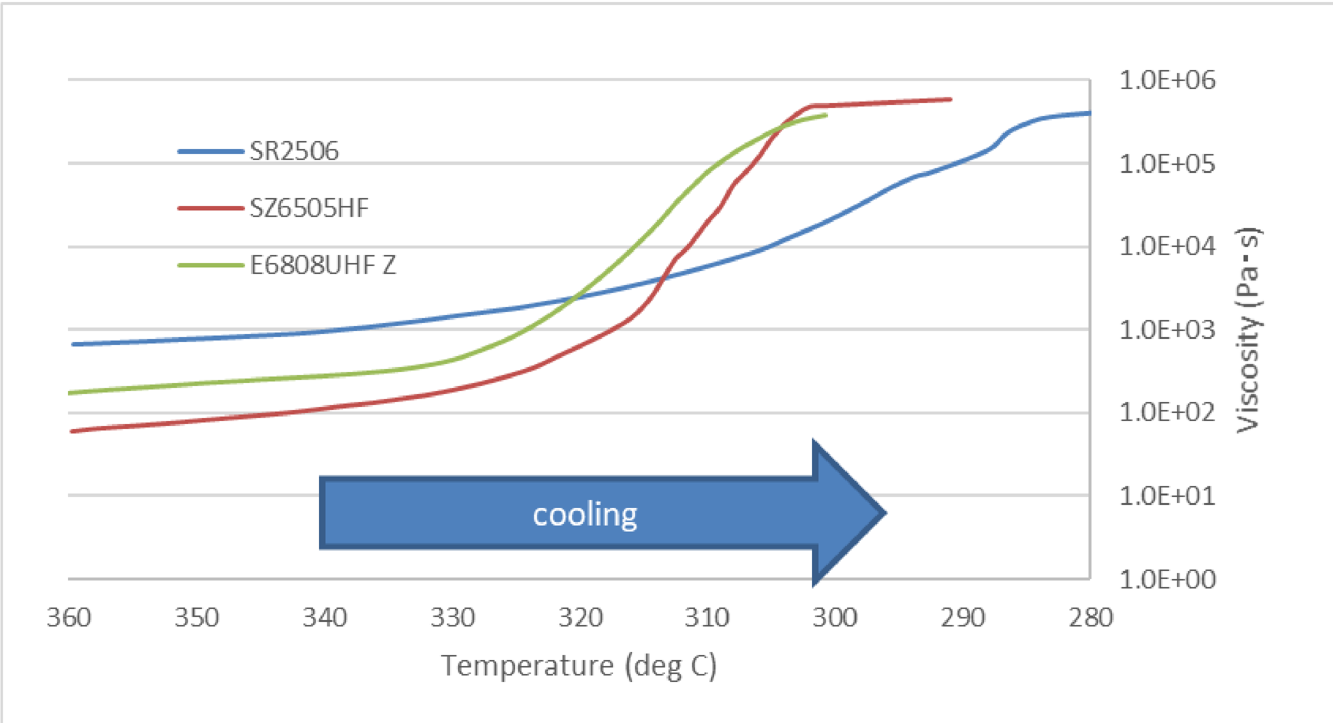

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Another measure of moldability and processability compares temperature vs. viscosity. Again, the two new grades ((SumikaSuper™ SR2506 (blue line) and SumikaSuper SZ6505HF (red line)) demonstrate improved performance vs. the standard grade (SumikaSuper E6808UHF Z LCP (green line)).

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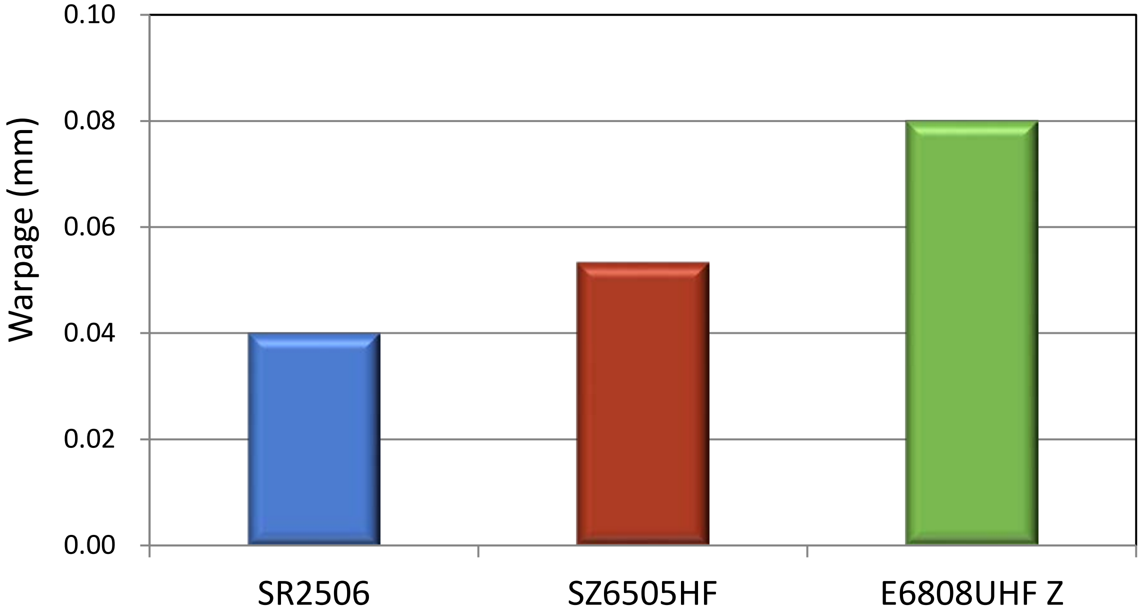

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The ability to minimize warpage and other dimensional changes is extremely important in such low-profile and thin-wall parts as fine-pitch connectors because post-mold dimensional changes due to stress relaxation can literally rip wires from connectors and boards and stop devices from operating properly. Shown above is a graph comparing warpage for two new grades ((SumikaSuper™ SR2506 (blue bar) and SumikaSuper SZ6505HF (red bar)) vs. the standard grade (SumikaSuper E6808UHF Z (green bar)) of fine-pitch connectors molded in LCP.

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Liquid Crystal Polymers for Fine-Pitch Connectors	SumikaSuper™		
	SR2506	SZ6505HF	E6808UHF Z
Molding Temperature (°C)	350	350	350
Specific Gravity	1.62	1.58	1.72
Mold Shrinkage — Machine Direction	0.21	0.22	0.22
Transverse Direction	0.51	0.60	1.02
Tensile Strength (MPa)	133	130	100
Elongation (%)	7.0	7.0	5.0
Flexural Strength (MPa)	147	140	120
Modulus (GPa)	11.7	11.2	9.4
Unnotched Izod Impact Strength	352	430	350
Distortion Temperature Under Load @ 182 MPa	233	244	240
@ 0.45 MPa	277	280	290
Thin-Wall Flexural Strength (mm) — 0.3	226	155	117
0.5	194	156	124
0.8	191	147	114
Flame Retardancy — UL* Class	V-0	V-0	V-0
Color	NC, BK	NC, BK	ALL
Thickness (mm)	0.30	0.10	0.10

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The table above provides select property comparisons for two new LCP grades (SumikaSuper™ SR2506 (blue column) and SumikaSuper SZ6505HF (red column)) vs. the standard LCP grade (SumikaSuper E6808UHF Z (green column)).

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