

Vectra® LCP
Zenite® LCP

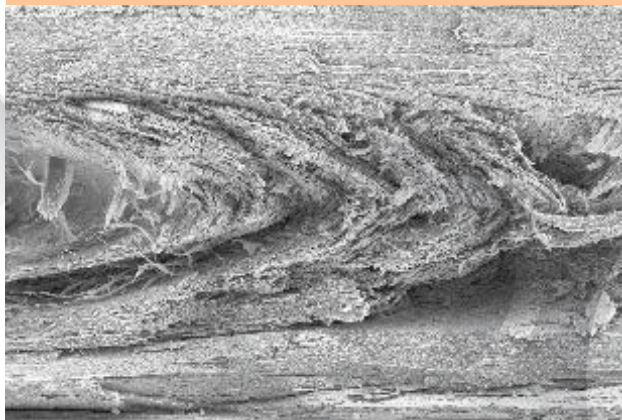
Liquid Crystal Polymers

Vectra® and Zenite® LCP are the tradenames of a range of thermotropic, i.e. melt processable, liquid crystal polymers (LCP) with very good heat resistance.

A characteristic feature of liquid crystal polymers is their molecular structure. These polymers consist of rigid, rod-like macromolecules. If a liquid crystal polymer melt is subjected to shear or stretching flow, as is the case in all thermoplastic processing operations, then the rigid macromolecules order themselves into fibers and fibrils which are frozen-in when the melt cools. This is how the specific morphology of liquid crystal polymers in the solid state is formed. The morphology is in fact very similar to that of wood (Fig. 1). In the LCP matrix, fibers of the same polymer are embedded. These polymers are therefore also described as self reinforcing. A fracture photomicrograph of Vectra® LCP is shown below in which the wood-like structure can be clearly discerned.

The fiber orientation increases by reducing wall thicknesses. Therefore the values for tensile and flexural modulus are relatively higher for smaller wall thicknesses (Fig. 2).

Fig. 1 Fracture Surface of Unfilled Vectra® LCP

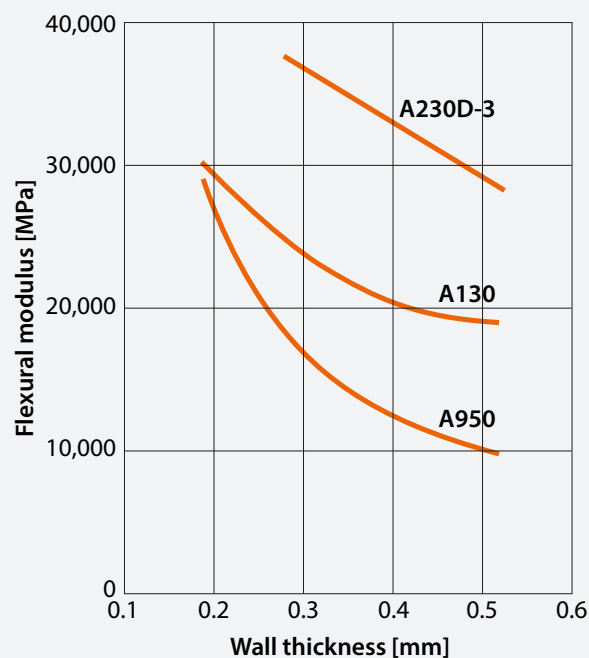


® = Registered trademark

Vectra® and Zenite® LCP are characterized by

- ▶ continuous service temperatures up to 240 °C short-term up to 340 °C
- ▶ inherent flame retardance to lowest wall thickness (UL 94 V-0, some with 5 V-A)
- ▶ very good chemical and oxidation resistance
- ▶ very high tensile strength and very high elastic modulus in the flow direction
- ▶ high impact strength
- ▶ very low coefficient of linear thermal expansion comparable with that of steel and ceramics
- ▶ very low heat of fusion (very fast cycling possible)
- ▶ very low melt viscosity
- ▶ flash-free injection molding
- ▶ very low water absorption

Fig. 2 Flexural modulus of different Vectra® LCP grades as function of small wall thicknesses, measured in flow direction at 23 °C, specimen 50 x 5 x 0.2 to 0.5 mm

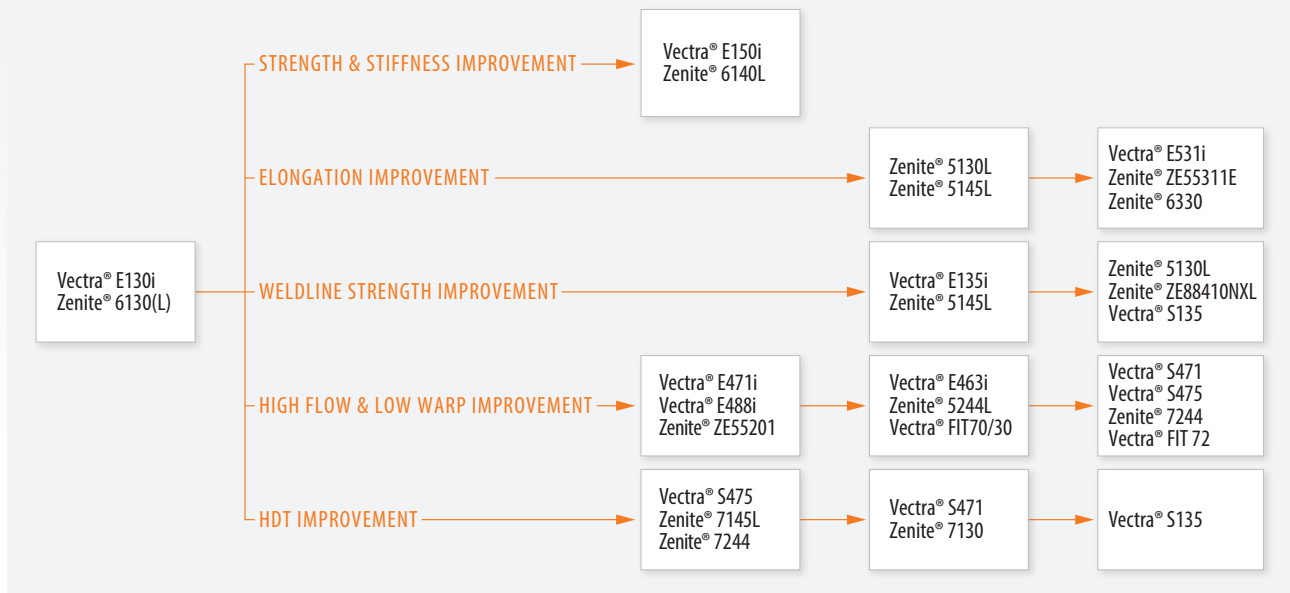


Tensile strength, rigidity and toughness values in the flow direction are higher the greater the degree of unidirectional melt orientation. These values therefore increase as wall thicknesses are reduced.

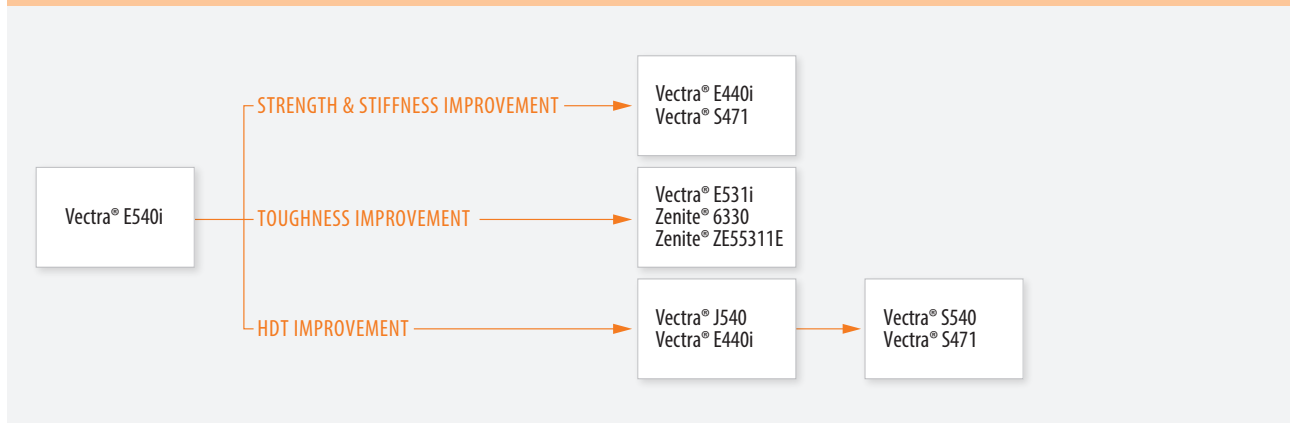
These properties of Vectra[®] LCP and Zenite[®] LCP, which are influenced by the high orientation of the macromolecules, display marked anisotropy. So strength and

rigidity in the direction of orientation are much higher than in the transverse direction, while the thermal expansion coefficient measured at right angles to the direction of orientation is higher than the value measured parallel to it. This anisotropy is considerably reduced by fillers and reinforcing materials and can be brought to a level comparable with other fiber reinforced polymers.

Tab. 1 · High Temperature Selection Guide: LCP for thin wall, lead-free SMT capability



Tab. 2 · High Temperature Selection Guide: LCP for appearance and surface quality



Grades

The comprehensive Vectra® and Zenite® LCP range is built around several base polymers which differ in their high temperature resistance, rigidity and flowability.

By compounding with a variety of fillers and reinforcing materials, the base polymers can be tailored to meet the requirements of many different applications.

Applications

Vectra® and Zenite® LCP are used for cookware applications, in electrical and electronic components, mainly connectors, components for audio/video/business machines, medical equipment, automotive and mechanical engineering and the aerospace industry.

Vectra® and Zenite® LCP are produced in an ion-free condensation process. Therefore, Vectra® and Zenite® LCP are well suited for applications in electronics, where partially ion concentrations below 5 ppm are demanded.

For many moldings exposed to high service stresses, Vectra® or Zenite® LCP is the preferred alternative to light metal alloys, thermosets and many other thermoplastics.

Supply form

Vectra® and Zenite® LCP are supplied as natural granules about 2.8 mm in size ("regular" pellets). Their "natural" color is ivory. The graphite-, carbon-black and carbon-fiber-filled grades are correspondingly black or anthracite in color. The standard packaging unit is a 25 kg bag.

The standard pellet size for Vectra® E130i usually is approx. 2 mm diameter ("small" pellets) and will be supplied in 20kg bags. But it is also available in "regular" pellet size.

Vectra® A230D-3 and B230 are only available in 20 kg bags.



Color masterbatches/coloration

Vectra[®] LCP can be colored in order to identify or differentiate between components. However, it is not a common practice to color match and RAL colors are not possible.

Color masterbatches with high pigment content can be supplied in a range of colors. Masterbatches are supplied as granules and are used for melt coloration of natural Vectra[®] LCP grades during processing. Typically, 1 part color masterbatch ($\geq 5\%$) is added to 20 parts natural granules. Lower concentrations are also possible if the color effect achieved is satisfactory.

For in-plant coloration of natural Vectra[®] LCP granules, only Vectra[®] LCP masterbatches should be used. In the case of modified or reinforced Vectra[®] LCP grades, the color of the filler or reinforcing material may influence the final shade. The pigment contents may reduce mechanical properties and flowability.

Some Vectra[®] LCP grades are supplied in pre-colored black formulations with various carbon black contents. These are denoted by the suffix D-1, D-2 or D-3 in the grade designation (e.g. A130D-2 or E130iD-2). A higher suffix means a higher pigment content.

A and B polymers are colored with A9500 masterbatch, Ei polymers are colored with E9500i masterbatch. S Polymers are colored with S9500 masterbatch. Coloring of S Polymer is currently restricted to black – for further information Celanese's technical service should be contacted. The following color concentrates for A, B and Ei resins are readily available:

Color Masterbatch for A, B-and Ei Polymer

VB	3166	K20	Ivory
VD	3003	K20	Standard Black
VD	3053	K20	FDA Black
VE	3104	K15	Purple
VG	3010	K20	Light Blue
VG	3066	K15	Blue
VJ	3129	K10	Bright Green
VJ	3040	K10	Emerald Green
VL	3072	K15	Yellow
VS	3035	K10	Red
VS	3125	K15	Red

Color Masterbatch Example

Vectra[®] A 9500 VJ 3040 K10

Let down ratio

Color

Masterbatch

Base polymer

The last two digits at the end of the color code designation give the recommended mix ratio of natural granules to color concentrate.

RAL codes are for color reference only, not for precise color matching.

			General Purpose						
			Vectra® A130	Vectra® E130i	Vectra® E135i	Vectra® E150i	Zenite® 6130	Zenite® 6130L	Zenite® 6140L
			MT1310	MT4310					
Property	Units	Method							
Total filler amount	%		30	30	35	50	30	30	40
Physical properties									
Density	kg/m ³	ISO 1183	1620	1610	1670	1810	1620	1620	1710
Mold shrinkage parallel / normal	%	ISO 294-4	0.2 / 0.4	0.1 / 0.1	0.0 / 0.3	0.2 / 0.5	0.15 / 0.8		0.05 / 0.5
Water absorption (23 °C - sat)	%	ISO 62-1	0.005	0.005	0.070				
Humidity absorption (23 °C / 50 % RH)	%	ISO 62-4	0.040	0.030		0.006			
Mechanical properties									
Tensile stress at break (5 mm/min)	MPa	ISO 527-2/1A	190	150	150	130	130	130	130
Tensile strain at break (5 mm/min)	%	ISO 527-2/1A	2.1	1.6	1.5	1.0	2.0	1.8	1.1
Tensile modulus (1 mm/min)	MPa	ISO 527-2/1A	15000	15000	16000	17500	13000	13000	17000
Flexural strength (23 °C)	MPa	ISO 178	280	220	225	205	190		190
Flexural modulus (23 °C)	MPa	ISO 178	14500	13500	17000	18600	11000	12000	16500
Compressive stress @ 1 % strain	MPa	ISO 604	125	93	100	125			
Compressive modulus	MPa	ISO 604	14500	14000	13500	18000			
Charpy impact strength @ 23 °C / -30 °C	KJ/m ²	ISO 179/1eU	33 / -	43 / 26	40 / -	19 / -	40 / 30	35 / -	23 / 20
Charpy notched impact strength @ 23 °C / -30 °C	KJ/m ²	ISO 179/1eA	26 / -	22 / 21	27 / -	9 / -	35 / 30	25 / -	15 / 15
Impact strength (Izod) @ 23 °C	KJ/m ²	ISO 180/1U	29	31	40	16			
Notched impact strength (Izod) @ 23 °C	KJ/m ²	ISO 180/1A	24	20	30	12			12
Rockwell hardness	M-Scale	ISO 2039-2	85	71	62	66			
Thermal properties									
Melting temperature (10 °C/min)	°C	ISO 11357-1,-2,-3	280	335	335	335	335	335	335
DTUL (HDT/A) 1.8 MPa	°C	ISO 75-1, -2	235	276	275	260	268	265	280
DTUL (HDT/B) 0.45 MPa	°C	ISO 75-1, -2	250				300		
DTUL (HDT/C) 8.0 MPa	°C	ISO 75-1, -2	190	216		225			
Vicat softening temperature B50 (50 °C/h 50 N)	°C	ISO 306	160	195	200	200			
Coefficient of linear thermal expansion (20 - 80 °C) parallel / normal	E-4/°C	ISO 11359-2			0.05 / 0.59		0.03 / 0.70	0.03 / 0.70	0.04 / 0.64
Coefficient of linear thermal expansion (-50 - 200 °C) parallel / normal	E-4/°C	ISO 11359-2		0.10 / 0.69					
Coefficient of linear thermal expansion (20 - 80 °C) parallel / normal*)	E-4/°C	ISO 11359-2	0.06 / 0.23	0.07 / 0.20		0.06 / 0.17			
Coefficient of linear thermal expansion (-50 - 200 °C) parallel / normal*)	E-4/°C	ISO 11359-2	0.05 / 0.20	0.05 / 0.19		0.06 / 0.17			
Electrical properties									
Relative permittivity - 2 GHz		IPCTM-650 2.5.5.13		4.23	4.37			4.16	
Dissipation factor - 2 GHz	E-4	IPCTM-650 2.5.5.13		60	60			50	
Relative permittivity - 1 MHz / 10 MHz		IEC 60250	3.7 / 3.2	3.3 / 3.2	4.1 / -	4.7 / -	4.0 / -	4.0 / -	
Dissipation factor - 1 MHz / 10 MHz	E-4	IEC 60250	180 / 80	250 / 200	30 / -	280 / -	310 / -	310 / -	
Relative permittivity gold plated - 1 MHz / 1 GHz		IEC 60250	5.2 / 5.0	6.8 / 6.3					
Dissipation factor gold plated - 1 MHz / 1 GHz	E-4	IEC 60250	1360 / 610	1880 / 360					
Volume resistivity	ohm · m	IEC 60093	1E13	1E13	1E14	1E13	>1E13	>1E14	>1E13
Surface resistivity	ohm	IEC 60093	>1E15	1E14	1E15	1E14	>1E15	>1E16	>1E15
Electric strength	KV/mm	IEC 60243-1	31	32	28	28	36	36	45

*) Method of sampling accord. to Vectra® LCP product brochure/ May 2008 vs., p. 23/ 24

Vectra[®], Zenite[®] LCP

Ultra High Precision										Ultra High Heat							
Vectra [®] E130G	Vectra [®] E463i	Vectra [®] E471i	Vectra [®] E473i	Vectra [®] E488i	Vectra [®] FIT30	Vectra [®] FIT70	Vectra [®] FIT72	Zenite [®] 5244L	Zenite [®] ZE55201	Vectra [®] S135	Vectra [®] S471	Vectra [®] S475	Vectra [®] S540	Zenite [®] 7130	Zenite [®] 7145L	Zenite [®] 7244	
30	40	35	32	44	44	36	36	40	50	35	45	32	40	30	45	40	
1610	1720	1670	1630	1770	1770	1650	1650	1710	1850	1670	1760	1650	1740	1620	1740	1730	
	0.1 / 0.4	0.1 / 0.5	-0.07 / 0.2	0.14 / 0.4		0.05 / 0.4	0.05 / 0.4	0.1 / 0.4		0.1 / 0.4	0.2 / 0.5	0.0 / 0.4	0.1 / 0.9	0.01 / 0.6	0.05 / 0.5	0.1 / 0.5	
	0.020	0.015		0.005						0.004							
		0.007								0.002			0.003				
140	110	130	115	110	130	110	110	131	88	140	120	135	100	150	120	115	
1.9	3.0	2.5	2.2	1.5	1.7	2.6	2.0	1.66	1.4	1.3	1.4	1.8	3.0	1.5	0.9	1.4	
12000	10000	13800	10900	13000	13000	11000	12000	14000	15800	15500	12000	12300	7500	17000	18000	14000	
170	130	180	150	160	170	140	140	198	165	230	185	180	130	210	180	180	
12000	10600	13500	10900	13000	12700	12000	12000	13100	12500	14500	12000	12000	9200	13000	17800	11300	
	53	82	59	115					21								
	7700	11000	9200	11000													
	30 / -	55 / -	33 / -	29 / -	26 / -	30 / -	30 / -	27 / -			10 / -		13 / -	30 / 22	18 / 13		
	5 / -	30 / -	20 / -	18 / -	6 / -	6 / -	8 / -	17 / -	4 / -	12 / -	6 / -	5 / -	5 / -	20 / 20	10 / 10	9 / -	
	30	60	30	28				28		14			15	30			
25	5	14	10	9						12	8	5	4	18			
	44	55	40	54											58		
335	335	335	335	335	328	331	331	318	335	350	350	350	350	352	355		
245	235	265	250	260	262	235	240	285	290	340	315	305	275	310	295	295	
273	270				286	278	284		300								
		220	159							267	271	213	135				
	185	200	190	200													
0.05 / 0.67	0.10 / 0.43			0.08 / 0.42	0.09 / 0.38	0.08 / 0.43	0.08 / 0.43	0.06 / 0.48	0.15 / 0.27					0.03 / 0.62	0.07 / 0.24	0.06 / 0.41	
		0.06 / 0.18	0.06 / 0.11							0.01 / 0.23	0.08 / 0.17	0.10 / 0.24	0.09 / 0.21				
		0.04 / 0.15	0.06 / 0.11							0.04 / 0.22	0.08 / 0.17	0.10 / 0.25	0.09 / 0.22				
								4.18					3.95				
								40					10				
	3.9 / -	3.8 / 3.7	4.0 / -	4.24 / 2.6					4.0 / -	3.5 / 3.4	4.0 / -	3.7 / -		3.7 / -	4.4 / -		
	35 / -	310 / 70	3400	450 / 190					310 / -	90 / 230	70 / -	80 / -		300 / -	240 / -		
>1E13	1E14	1E14	1E14	1E14	1E14	2E14			>1E13	1E15	1E14			>1E13	>1E13		
>1E14	1E16	>1E15	>1E15	1E17	1E16	6E15			>1E15	1E17	1E11			>1E15	>1E15		
59	53	49	55						37	37				45	36		

			Tough & Robust									
			Vectra® A115	Vectra® B230	Vectra® E115i	Zenite® 5115L	Zenite® 5130L	Zenite® 5145L	Zenite® ZE88410NXL	Vectra® A230	Vectra® A700	Vectra® A725
			MT1305									
Property	Units	Method										
Total filler amount	%		15	30	15	15	30	45	40	30	30	25
Physical properties												
Density	kg/m ³	ISO 1183	1500	1500	1460		1630	1750	1670	1500	1630	1560
Mold shrinkage parallel / normal	%	ISO 294-4	0.1 / 0.4	0.0 / 0.1	-0.2 / 0.5		0.05 / 0.7	0.09 / 0.5	0.1 / 0.3	0.1 / 0.3	0.2 / 0.4	0.3 / 0.8
Water absorption (23 °C / 24 h)	%	ISO 62-1	0.006	0.008								0.020
Humidity absorption (23 °C / 50 % RH - sat)	%	ISO 62-4	0.003							0.06		
Mechanical properties												
Tensile stress at break (5 mm/min)	MPa	ISO 527-2/1A	200	200	175	175	145	115	130	149	144	96
Tensile strain at break (5 mm/min)	%	ISO 527-2/1A	3.1	0.7	2.3	3.3	3.5	3.1	1.0	1.1	1.4	4.2
Tensile modulus (1 mm/min)	MPa	ISO 527-2/1A	12000	31800	14000	11500		15000	15900	23500	13000	8100
Flexural strength (23 °C)	MPa	ISO 178	250	300	210	170	170	190	200	228	220	121
Flexural modulus (23 °C)	MPa	ISO 178	12400	25500	14000	10500	11000	11000	15800	26000	13400	7700
Compressive stress @ 1 % strain	MPa	ISO 604	85	204				21		136	100	
Compressive modulus	MPa	ISO 604	10000	33000						23500	14500	
Charpy impact strength @ 23 °C / -30 °C	KJ/m ²	ISO 179/1eU	48 / -	15 / -						13 / -	15 / -	28 / -
Charpy notched impact strength @ 23 °C / -30 °C	KJ/m ²	ISO 179/1eA	42 / -	6 / -						7 / -	7 / -	24 / -
Impact strength (Izod) @ 23 °C	KJ/m ²	ISO 180/1U	61	12	101					18	24	24
Notched impact strength (Izod) @ 23 °C	KJ/m ²	ISO 180/1A	45	6	40				8	7	15	17
Rockwell hardness	M-Scale	ISO 2039-2	80	99	43					83	85	44
Thermal properties												
Melting temperature (20 °C/min)	°C	ISO 11357-1,-2,-3	280	280	335	319	320	319	328	280	280	280
DTUL (HDT/A) 1.8 MPa	°C	ISO 75-1, -2	230	235	252	275	275	290	263	233	232	153
DTUL (HDT/B) 0.45 MPa	°C	ISO 75-1, -2	250	250	298					250	250	
DTUL (HDT/C) 8.0 MPa	°C	ISO 75-1, -2	157	186						193	178	93
Vicat softening temperature B50 (50 °C/h 50 N)	°C	ISO 306	162	167	202				239	179	156	
Coefficient of linear thermal expansion (20 - 80 °C) parallel / normal	E-4/°C	ISO 11359-2						0.07 / 0.60	0.12 / 0.82			
Coefficient of linear thermal expansion (-50 - 200 °C) parallel / normal	E-4/°C	ISO 11359-2										
Coefficient of linear thermal expansion (20 - 80 °C) parallel / normal*)	E-4/°C	ISO 11359-2	0.10 / 0.18	0.01 / 0.09						0.02 / 0.06	0.08 / 0.25	0.10 / 0.31
Coefficient of linear thermal expansion (-50 - 200 °C) parallel / normal*)	E-4/°C	ISO 11359-2	0.05 / 0.15	0.01 / 0.08						0.02 / 0.06	0.08 / 0.20	0.07 / 0.32
Electrical properties												
Relative permittivity - 2 GHz		IPCTM-650 2.5.5.13			3.94	3.76	4.07					
Dissipation factor - 2 GHz	E-4	IPCTM-650 2.5.5.13			50	30	40					
Relative permittivity - 1 MHz / 10 MHz		IEC 60250	3.0 / 2.9	32 / -		2.5 / -	3.3 / -	3.9 / -				
Dissipation factor - 1 MHz / 10 MHz	E-4	IEC 60250	180 / 80			159 / -	80 / -	180 / -				
Relative permittivity gold plated - 1 MHz / 1 GHz		IEC 60250										
Dissipation factor gold plated - 1 MHz / 1 GHz	E-4	IEC 60250										
Volume resistivity	ohm · m	IEC 60093	1E13	1E03	>1E14			1E13		1E00	1E03	1E01
Surface resistivity	ohm	IEC 60093	>1E15	1E02	>1E15			1E15	1E17	1E01	1E05	1E04
Electric strength	KV/mm	IEC 60243-1	34		33			45	33			

*) Method of sampling accord. to Vectra® LCP product brochure/ May 2008 vs., p. 23/ 24

Vectra[®], Zenite[®] LCP

Electrically Functional					Appearance							Speciality					
Vectra [®] E820iPd	Vectra [®] E830iPd	Vectra [®] E840iLDS	Vectra [®] E845iLDS	Zenite [®] ZE5520S	Vectra [®] E440i	Vectra [®] E531i	Vectra [®] E540i	Vectra [®] J540	Zenite [®] ZE55311E	Zenite [®] 6330	Vectra [®] A950	Vectra [®] A430	Vectra [®] A435	Vectra [®] A625	Vectra [®] S625	Vectra [®] T.rex541	
							MT4350				MT1300		MT1335				
42	34	39	41	15	42	31	40	40	31	30	none	25	35	25	25	40	
1790		1810	1770	1890	1770	1645	1740	1740	1640	1640	1400	1500	1620	1540	1530	1740	
0.4 / 1.2		0.1 / 0.5	0.0 / 0.2	0.1 / 0.6	0.0 / 0.5	0.0 / 0.5	0.0 / 0.5	0.07 / 0.37		0.0 / 0.7	0.0 / 0.7	0.0 / 0.7	0.1 / 0.4	0.1 / 0.5	0.0 / 0.8		
		0.011					0.008				0.006		0.003				
0.002		0.004					0.005				0.003		0.002	0.030			
89	140	102	130	125	118	120	105	105	130	130	182	156	171	140	121	110	
3.6	1.8	3.4	1.7	2.5	2.0	4.0	3.2	3.3	4.3	5.0	3.4	6.2	3.3	5.7	3.0	3.2	
8000	15000	9300	14000	14260	11600	9000	9800	9000	8500	10000	10600	7000	11000	9000	8300	10700	
120	180	109	180	190	165	130	125	120	140		158	125	206	140	152	130	
8800	14500	10500	14000	12165	12000	10000	10000	10000	9000	9500	9100	7100	10500	10500	9500	11700	
											70	38	77	56			
												6000	10500	9000			
30 / 17		30 / -		36 / -	24 / -		58 / -			60 / 40	267 / 53	86 / -	38 / -	67 / -			
4 / 3	21 / -	5 / -	20 / -	30 / -	6 / -		6 / -		12	9 / 8	95 / -	28 / -	26 / -	11 / -			
28		33		35	25		35				252	67	33	62	25		
4		6		29	9	8	5	5			95	34	17	22	4		
												55	55	62			
335	335	335	335	335	335	335	335	350	320	335	280	280	280	280	350	357	
215	245	227	255	276	260	225	230	240	258	245	187	165	230	185	271	245	
255										275		227	250	225			
119		137			177		149				94	89	162	114	129		
							195				145	138	146	159	227		
			0.08 / 0.58				0.10 / 0.36			0.08 / 0.40							
0.23 / 0.66							0.09 / 0.40										
0.23 / 0.49		0.12 / 0.27			0.11 / 0.20		0.11 / 0.11				0.04 / 0.38	0.01 / 0.46	0.01 / 0.19	0.09 / 0.30	0.12 / 0.24		
0.21 / 0.47		0.13 / 0.30			0.11 / 0.21		0.11 / 0.12				0.05 / 0.33	0.01 / 0.41	0.01 / 0.17	0.09 / 0.30	0.12 / 0.25		
		4.3	4.35	6.07					4.27								
		33	50	40					140								
		2.94 / -	3.87 / -	4.52 / -			3.6 / 3.4			3.4 / -	3.0 / -	2.7 / 2.9	3.1 / 2.8	13.0 / 10.0			
		1153 / -	370 / -	190 / -			310 / 250			310 / -	200 / -	160 / 80	160 / 80	1500 / 1400			
6.8 / 6.6												4.3 / 4.2					
1630 / 100												860 / 400					
		2E14			1E14	1E14	1E14			>1E13	1E13	1E13	1E13	1E14			
		2E16			>1E15	1E15	1E15			>1E15	1E14	1E15	>1E15	1E11			
							46			35	47	36	32				



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