Celanese

The chemistry inside innovation™

Vectra® LCP

Liquid Crystal Polymers (LCP)

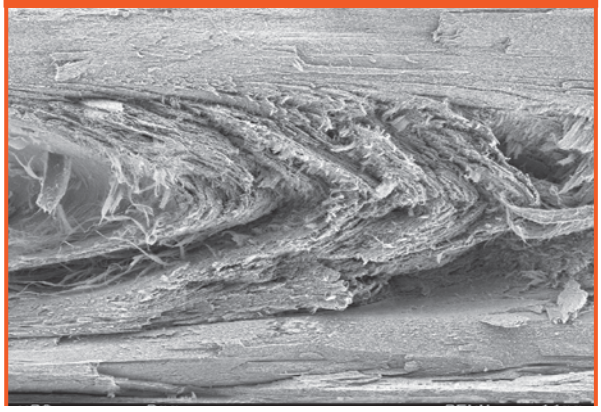
Product Information

Vectra is the tradename 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 is shown below in which the wood-like structure can be clearly discerned.

The fiber orientation increases by reduced wall thicknesses. Therefore the values for tensile and flexural modulus are relatively higher for smaller wall thicknesses, see fig. 2.

Fig. 1 • Fracture Surface of Unfilled Vectra LCP



Vectra is characterized by

- continuous service temperatures up to 240°C, short-term up to 340°C,
- inherent flame retardance (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 moulding,
- very low water absorption.

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, 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.

Table 1 • Vectra grades – Survey					
Glass-fiber-reinforced	**A115**				
	A130		**E130i**	**S135**	
			E480i		
			E150i	**S150**	
Carbon-fiber-reinforced	**A230D-3**	**B230**			
Filler/fiber	**A430**		**E440i**		
	A435 FDA		**E471i**	**S471**	
			E473i	**S475**	
			E488i		
Mineral-filled			**E540i**	**S540**	
Graphite-filled	**A625**			**S625**	
Conductive (electr.)	**A700**				
	A725				
Platable			**E820i**		
			E820i Pd		
			E830i Pd		
			E840i LDS		
Alloys	**V140**		**V143XL**		
			V143LC		
Extrudable (unfilled0	**A950**				**V400P**

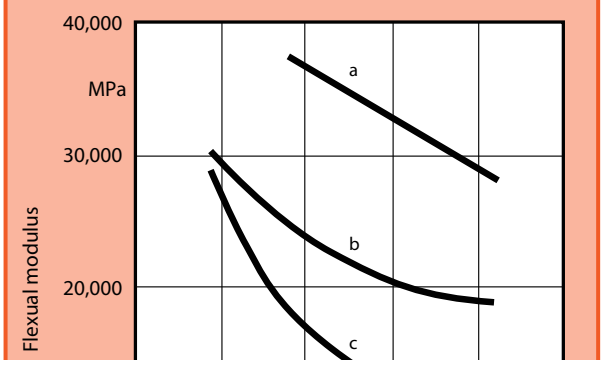
Table 2 • Recommendations for grade selection		
Best all around characteristics	→	**A130,E130i**
High temperature stress (SMD)	→	**E130i, E480i, E150i, S135, S150**
Highest rigidity	→	**B230**
High rigidity + highest electr. conductivity	→	**A230D-3**
High impact strength and good surface quality	→	**E540i, S540**
Very good flowability	→	**E130i, E471i, S475**
High electrical conductivity	→	**A700, A725**
Best resistance to chemicals	→	**A625**
Platable surfaces (e.g. Shields, MID)	→	**E820i, E820i Pd, E830i Pd, E840i LDS**
Slip-/Slide applications with low wear	→	**A430, A435 FDA, A625, S625**
Low warp	→	**E440i, E471i, E473i, E488i, S471, S475**
Suitable for medical applications	→	**MT1300, MT1305, MT1310, MT1335, MT4310, MT4350**

Grades

The comprehensive Vectra 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 (Table 1).

The product code consists of a letter followed by three digits. The letter denotes the base polymer used and the first digit the type of filler or reinforcing material. With the 100, 200, 500 and 600 grades, the last two digits indicate the amount of filler or reinforcing material used in percent by weight when these digits end with a "0" or "5." With the other grades, the last two digits are an internal code characterizing the composition and proportion by weight of the modifying material. Table 1 explains the product nomenclature and surveys the grades currently available.

Fig. 2 • Flexural modulus of different Vectra 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



Applications

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

Vectra liquid crystal polymer is produced in an ion-free condensation process. Therefore, Vectra is well suited for applications in electronics, where partially ion concentrations below 5 ppm are demanded.

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

For a pre-selection of a Vectra grade in table 2 selection criteria are given.

Supply form

Vectra is supplied as natural granules about 2.8 mm in size ("regular" pellets). Their "natural" color is beige. 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 is only available in 20 kg bags.

Color masterbatches/coloration

Vectra can be colored in order to identify or differentiate between components. However, it is not a common practice to color match and RAL colours 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 grades during processing. Typically, 1 part color masterbatch (5 %) is added to 19 parts natural granules. Lower concentrations are also possible if the color effect achieved is satisfactory.

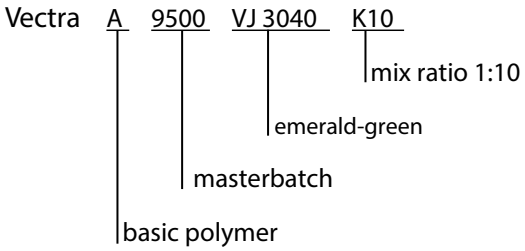
For in-plant coloration of natural Vectra granules, only Vectra masterbatches should be used. In the case of modified or reinforced Vectra grades, the color of the filler or reinforcing material may influence the final shade. The pigment contents may reduce mechanical properties and flowability.

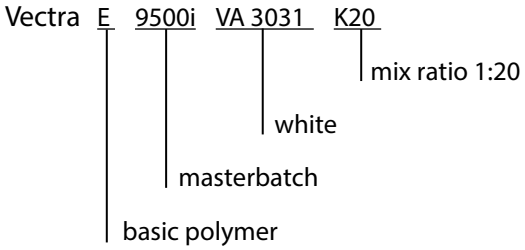
Some Vectra grades are supplied in melt-colored black formulations with various carbon black contents. These are denoted by the suffix D-1, D-2 or D-3 in the grade designation (e.g. A130D-2 or E130iD-2). A higher suffix means a higher pigment content.

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:

VA	3031	K20	white
VD	3003	K20	black
VG	3010	K20	blue
VJ	3040	K10	emerald-green
VL	3021	K10	(for A-Polymer) yellow
VL	3043	K10	(for Ei-Polymer) yellow
VS	3035	K10	red

All color concentrates are cadmium-free. The last two digits at the end of the color code designation give the recommended mix ratio of natural granules to color concentrate, e.g.:





Physical properties			Units	Method	A115 (MT1305)	A130
Filler/Reinforcement			weight %	ISO 3451 [1)]	15	30
Density			g/cm³	ISO 1183	1.5	1.62
Water Absorption after 24 hours (immersion at @23°C)			%	ISO 62-1	0.02	0.005
Moisture Absorption (23°C, 50% RH) saturation			%	ISO 62-4	–	0.04
Mould Shrinkage	flow/transverse		%	ISO 294-4	0.1 / 0.4	0.2 / 0.4
Mechanical properties,						
Tensile Strength			MPa	ISO 527 -1, -2	200	190
Elongation at Break			%	ISO 527 -1, -2	3.1	2.1
Tensile Modulus			MPa	ISO 527 -1, -2	12000	15000
Flexural Strength			MPa	ISO 178	250	280
Flexural Modulus			MPa	ISO 178	12400	14500
Compressive Strength at 1% deflection			MPa	ISO 604	85	100
Compressive Modulus			MPa	ISO 604	10000	14500
Izod Impact: Un-Notched			kJ/m²	ISO 180/1 U	61	29
Izod Impact: Notched			kJ/m²	ISO 180/1 A	45	24
Charpy Impact: Un-Notched			kJ/m²	ISO 179/1 eU	48	33
Charpy Impact: Notched			kJ/m²	ISO 179/1 eA	42	26
Rockwell Hardness (M-Scale)			—	ISO 2039-2	80	85
Thermal properties						
Deflection Temperature Under Load	DTUL (HDT--A) 1.8 MPa		°C	ISO 75 -1, -2	230	235
	DTUL (HDT-C) 8 MPa		°C	ISO 75 -1, -2	157	190
Vicat Softening Temperature	VST/B/50		°C	ISO 306	162	160
Coefficient of Linear Thermal Expansion (20°C to 80°C)	flow		x 10⁻⁶/K	ISO 11359 -1, -2	10	6
	transverse		x 10⁻⁶/K	ISO 11359 -1, -2	18	23
Coefficient of Linear Thermal Expansion (-50°C to 200°C)	flow		x 10⁻⁶/K	ISO 11359 -1, -2	5	5
	transverse		x 10⁻⁶/K	ISO 11359 -1, -2	15	20
Melting Point			°C	ISO 11357	280	280
Electrical properties, measured at standard conditioning atmosphere ISO 291 – 23/50						
Volume Resistivity			Ω • m	IEC 60093	10^{13}	10^{13}
Surface Resistivity			Ω	IEC 60093	$>10^{15}$	$>10^{15}$
Dielectric Strength P25/P75			kV/mm	IEC 60243 -1	34	31
Relative Permittivity, ε_r	Gold Plated	1GHz	—	IEC 60250	–	5.2
(Dielectric Constant) DC		1GHz	—	IEC 60250	–	5
Dielectric Loss Tangent, δ‰	Gold Plated	1MHz	—	IEC 60250	–	0.136
(Dissipation Factor)		1GHz	—	IEC 60250	–	0.061
Relative Permittivity, ε_r	unplated	1MHz	—	IEC 60250	3	3.7
(Dielectric Constant) DC		10MHz	—	IEC 60250	2.9	3.2
Dielectric Loss Tangent, δ	unplated	1MHz	—	IEC 60250	0.018	0.018
(Dissipation Factor)		10MHz	—	IEC 60250	0.008	0.008
Comparative Tracking Index	CTI		—	IEC 60112	200	175
Flammability						
Underwriter Laboratories (more information see www.UL.com)			Class	UL 94	V-0	V-0

[1)] as applicable

Glass Fiber Reinforced					Carbon Fiber Reinforced	
E130i (MT4310)	**E480i**	**E150i**	**S135**	**S150**	**A230D-3**	**B230**
30	40	50	35	50	30	30
1.61	1.71	1.81	1.67	1.81	1.50	1.50
0.005	–	–	–	–	–	0.008
0.03	–	0.006	–	–	–	–
0.1 / 0.5	–	0.2 / 0.5	0.4 / 0.6	–	–	0.0 / 0.1
150	135	130	140	125	149	200
1.6	1.8	1	1.3	–	1.1	0.7
15000	–	17500	15500	–	23500	31800
220	200	205	230	210	228	300
13500	16000	18600	14500	20000	26000	25500
93	–	125	–	–	–	204
14000	–	18000	–	–	–	33000
31	–	16	14	–	18	12
20	20	12	14	–	7	6
43	–	19	–	–	13	15
22	35	9	12	9	7	6
71	–	66	–	–	–	99
276 216	265 –	260 225	340 267	330 281	233 193	235 186
195	–	200	–	–	179	167
7 20	– –	6 17	1 23	6 15	2 6	0 9
5 19	– –	6 17	4 22	6 14	2 6	1 8
335	335	335	350	350	280	280
10^{13}	10^{14}	10^{13}	10^{15}	–	10^{0}	10^{3}
10^{14}	10^{14}	10^{14}	10^{17}	–	10^{1}	10^{2}
32	42	28	37	32	–	–
6.8 6.3	– –	– –	– –	– –	– –	– –
0.188 0.036	– –	– –	– –	– –	– –	– –
3.3 3.2	4 –	4.7 –	3.5 3.4	4.6 –	– –	– –
0.025 0.02	0.029 –	0.028 –	0.009 0.023	0.007 –	– –	– –
175	150	–	–	125	–	–
V-0	V-0	V-0	V-0	V-0	–	V-0

Filler/Fiber Modified						
A430	A435 FDA (MT1335)	E440i	E471i	E473i	E488i	S471
25	35	42	35	32	43	45
1.50	1.62	1.77	1.67	1.63	1.77	1.76
–	0.003	–	–	–	–	–
–	0.002	–	–	–	–	–
0.0 / 0.7	0.1 / 0.4	–	0.1 / 0.5	–	–	0.2 / 0.5
156	171	118	130	115	110	120
6.2	3.3	2.0	2.5	2.2	1.5	1.4
7000	11000	11600	–	10900	13000	–
125	206	165	180	150	160	185
7100	10500	12000	13500	10900	13000	12000
38	77	–	–	59	–	2
6000	10500	–	–	9200	–	–
67	33	25	60	30	–	8
34	17	9	14	10	8	5
86	38	24	55	33	–	10
28	26	6	30	20	–	6
55	55	–	–	40	–	–
165	230	260	265	250	260	315
89	162	177	220	159	–	271
138	146	–	200	190	–	–
1	0	11	6	6	–	8
46	19	20	18	11	–	17
1	1	11	4	6	–	8
41	17	21	15	11	–	17
280	280	335	335	335	338	350
10^{13}	10^{13}	–	10^{14}	10^{14}	–	10^{14}
10^{15}	$>10^{15}$	–	$>10^{15}$	$>10^{15}$	–	10^{11}
36	32	–	53	49	–	–
4.3	–	–	–	–	–	–
4.2	–	–	–	–	–	–
0.086	–	–	–	–	–	–
0.040	–	–	–	–	–	–
2.7	3.1	–	3.8	3.5	–	4.0
2.9	2.8	–	3.7	3.4	–	–
0.016	0.016	–	0.031	0.032	–	0.007
0.008	0.008	–	0.007	0.034	–	–
225	175	–	200	175	–	150
V-0	V-0	–	V-0	V-0	–	V-0

	Mineral Filled		Grafite Filled	
S475	**E540i (MT4350)**	**S540**	**A625**	**S625**
32	40	40	25	25
1.65	1.74	1.73	1.54	1.53
–	–	–	–	–
–	0.005	0.003	0.03	–
–	0.0 / 0.5	0.1 / 0.9	0.1 / 0.5	0.0 / 0.8
135	105	98	140	120
1.8	3.2	3	5.7	3.4
12300	9800	7900	9000	8300
180	125	130	140	150
12000	10000	9300	10500	9400
–	–	–	56	–
–	–	–	9000	–
–	35	15	62	25
5	5	3	22	4
–	58	13	67	–
5	6	5	11	–
–	–	–	62	–
305 213	230 149	275 135	185 114	270 129
–	–	–	159	227
10 24	11 11	9 21	9 26	12 24
10 25	11 12	9 22	9 30	12 25
350	335	350	280	350
–	10^{14}	–	10^{14}	–
–	10^{15}	–	10^{11}	–
–	46	–	–	–
– –	– –	– –	– –	– –
– –	– –	– –	– –	– –
3.7 –	3.6 3.4	– –	13.0 10.0	– –
0.008 –	0.031 0.025	– –	0.150 0.140	– –
–	200	–	200	–
V-0	V-0	–	V-0	–

						Specialty Grades	
Electrical Conductive		Plateable				Alloys	
A700	**A725**	**E820i**	**E820i Pd**	**E830i Pd**	**E840i LDS**	**V140**	**V143XL**
30	24	40	42	30	39	40	42
1.63	1.56	1.78	1.79	1.67	1.81	1.67	1.67
–	0.020	–	–	–	–	–	–
–	–	0.005	0.002	–	0.005	–	–
0.2 / 0.4	0.3 / 0.8	0.3 / 1.2	0.4 / 1.2	–	0.1 / 0.5	0.2 / 0.6	0.3 / 0.6
144	96	100	89	145	102	130	145
1.4	4.2	4.0	3.6	1.8	3.4	1.0	1.3
13000	8100	8800	8000	15000	9300	16000	16000
220	121	130	120	190	113	210	220
13400	7700	9000	8800	14000	10300	16500	15700
100	–	–	–	–	–	–	–
14500	–	–	–	–	–	–	–
315	24	44	30	–	33	–	–
13	15	7	4	31	6	7	9
15	28	49	28	–	30	–	–
7	24	8	4	–	–	11	–
85	44	60	–	–	–	–	–
232 178	153 93	220 130	215 119	265 –	227 137	270 –	265 –
156	–	203	–	–	335	–	–
8 25	10 31	17 57	23 49	– –	12 27	11 21	8 30
8 20	7 32	16 56	21 47	– –	13 30	7 15	7 28
280	280	335	335	335	335	280	335
10^{3}	10^{1}	10^{13}	–	–	10^{15}	10^{12}	10^{14}
10^{5}	10^{4}	10^{15}	–	–	10^{13}	10^{15}	$>10^{16}$
–	–	29	–	–	–	25	33
– –	– –	7.2 6.7	6.8 6.6	– –	– –	– –	– –
– –	– –	0.165 0.038	0.163 0.010	– –	– –	– –	– –
– –	– –	– –	– –	– –	– –	3.7 –	3.5 3.4
– –	– –	– –	– –	– –	– –	0.005 –	0.160 0.007
175	–	175	175	–	–	–	–
V-0	V-0	V-0	V-0	–	–	V-0	V-0

	Extrudable	
V143LC	**A950 (MT1300)**	**V400P**
40	unfilled	unfilled
1.67	1.40	1.40
–	–	–
–	0.03	0.04
–	0.0 / 0.7	0.0 / 0.5
145	182	180
1.3	3.4	1.3
16000	10600	13200
225	158	180
15500	9100	12000
–	70	–
–	–	–
–	252	–
9	95	60
–	267	58
–	95	46
–	–	–
265	187	108
–	94	–
–	145	–
–	4	–
–	38	–
–	5	–
–	33	–
335	280	212
–	10^{13}	–
–	10^{14}	–
–	47	–
–	–	–
	–	–
–	–	–
–	–	–
–	3.0	–
–	–	–
–	0.020	–
–	–	–
–	150	–
–	V-0	–

Quality management

Meeting the quality requirements of our customers is a critical activity for Celanese. We constantly pursue and update the certifications needed for this purpose. Our quality management system has been certified to ISO 9000 standards since the early 1990s. In 2003, we built on this foundation by implementing the Global Celanese Integrated Management System (TIMS) for quality, environmental and risk management.

Important certifications include the following standards:

- ISO 9001
- ISO 14001
- ISO/TS 16949
- ISO/IEC 17025

Quality Management System Certifications under ISO 9001:2000 and ISO/TS 16949:2002 have now been achieved for all production sites and supporting remote locations of Celanese worldwide. The ISO/TS 16949:2002 standard combines the automotive regulations in Europe of VDA 6.1, EAQF and AVSQ with the requirements of QS-9000 in North America and supersedes all of these. Celanese received the certification for this standard in 2003.

All production sites of Celanese are certified under ISO 14001:2004, the Environmental System Standard.

The appropriate Celanese laboratories are accredited to meet general requirements according to ISO/IEC 17025:2005 for testing and calibration laboratories.

Our www.Celanese.com website provides further information under “About Celanese” > “Quality and Certifications”. This information includes the details of business lines and facilities covered and PDF files of all certificates of registration.

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ENGINEERED MATERIALS

celanese.com/engineered-materials

Engineered Materials

- Celanex® thermoplastic polyester (PBT)
- Hostaform® and Celcon® acetal copolymer (POM)
- Celstran,® Compel® and Factor® long fiber reinforced thermoplastic (LFRT)
- Celstran® continuous fiber reinforced thermoplastic (CFR-TP)
- Fortron® polyphenylene sulfide (PPS)
- GUR® ultra-high molecular weight polyethylene (UHMW-PE)
- Impet® thermoplastic polyester (PET)
- Riteflex® thermoplastic polyester elastomer (TPC-ET)
- Thermx® polycyclohexylene-dimethylene terephthalate (PCT)
- Vandar® thermoplastic polyester alloy (PBT)
- Vectra® and Zenite® liquid crystal polymer (LCP)

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