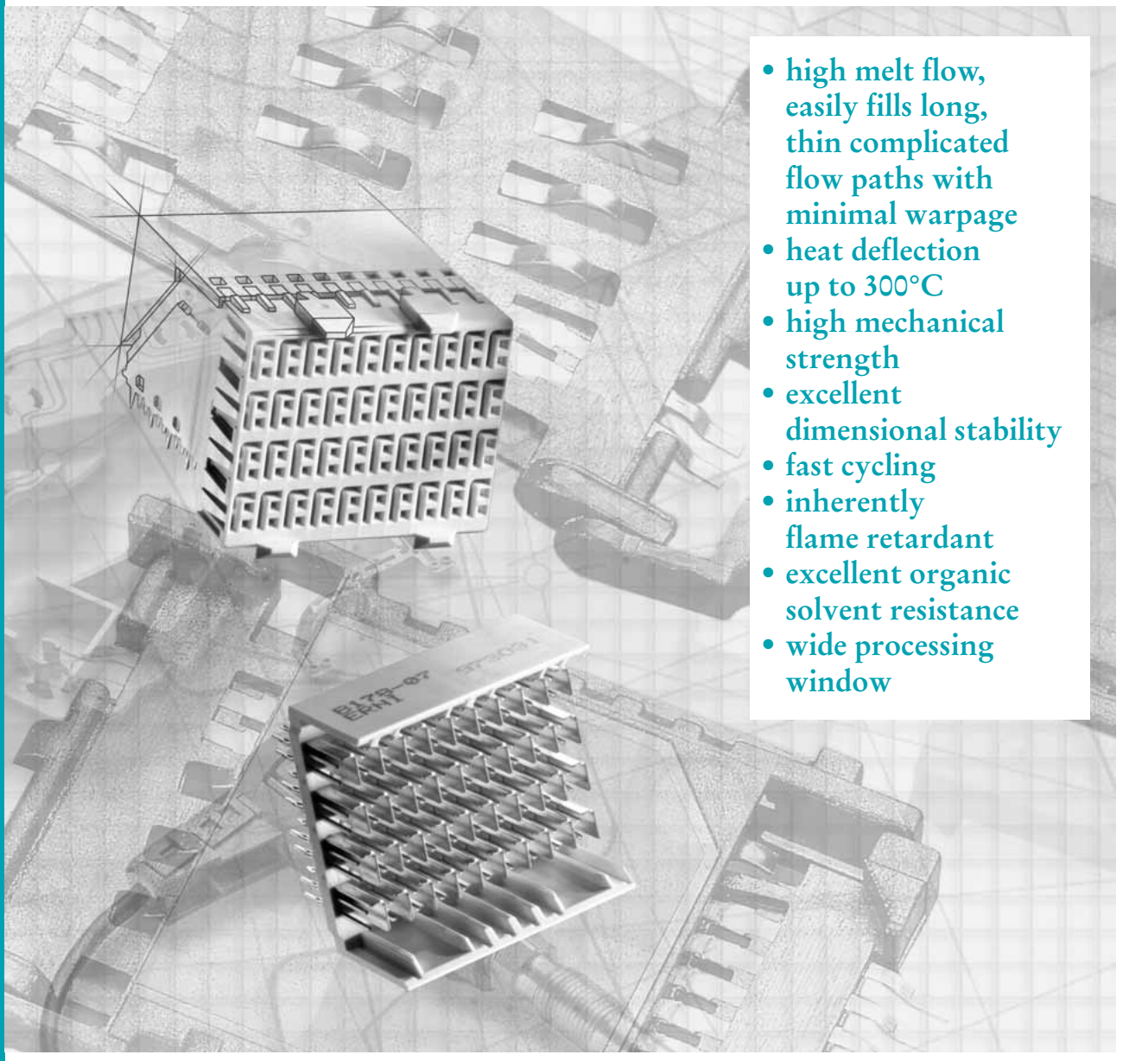
Europe

Vectra®

liquid crystal polymers (LCP)



- high melt flow, easily fills long, thin complicated flow paths with minimal warpage
- heat deflection up to 300°C
- high mechanical strength
- excellent dimensional stability
- fast cycling
- inherently flame retardant
- excellent organic solvent resistance
- wide processing window

Product Information

Ticona

Vectra is the tradename of a range of thermotropic, ie melt processable, liquid crystal polymers (LCP) with 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 fibres 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, fibres of the same polymer are embedded. These polymers are therefore also described as selfreinforcing. A fracture photomicrograph of Vectra is shown below in which the wood-like structure can be clearly discerned.

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

Abb. 1 · Fracture Surface of Unfilled Vectra LCP

Vectra is characterized by

- continuous service temperatures up to 240°C, short-term up to 300°C,
- inherent flame retardance (UL 94 V-0),
- 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 orietation of the macromolecules, display marked anistropy. 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 brough to a level comparable with other fibre-reinforced polymers.

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

Vectra contains only an extremely small proportion of ionic impurities and therefore offers advantages over other materials, eg in the electronics sector.

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

® = registered trademark

Table 1 · Vectra grades – Survey

Glass-fibre-reinforced	**A 115** **A 130** **A 150**	**B 130**	**C 115** **C 130** **C 150**	**D 130 M**	**E 130 i**	**H 130** **H 140**	**L 130** **L 140**	**T 130**
Carbon-fibre-reinforced	**A 230**	**B 230**						
Fibre/filler-modified	**A 410** **A 430** **A 435**							
Mineral-filled	**A 515** **A 530**		**C 550**		**E 530 i**			
Graphit-modified	**A 625**							
Conductive	**A 700** **A 725**							
Platable			**C 810**		**E 820 i** **E 820 i Pd**			
Unreinforced	**A 950**	**B 950**	**C 950**					

Table 2 · Recommendations for grade selection

Best allround characteristics	→	**A 130, L 130**
High temperature stress (SMD)	→	**C 130, E 130i, H 130/H 140, E 530 i, T 130**
High rigidity	→	**B 130**
Highest rigidity + conductivity	→	**A 230, B 230**
High impact strength and good surface quality	→	**A 515, A 530**
Very good flowability	→	**E 130i, D 130 M, T 130**
High conductivity	→	**A 230/B 230, A 700, A 725**
Best resistance to chemicals	→	**A 625**
Platable surfaces (e.g. Shields, MID)	→	**E 820i, E 820i Pd, C 810, A 530, A 230**
Sliding applications with low wear	→	**A 430, A 435**
Suitable for medical applications	→	**A 130, A 530**

Product Properties

Vectra®

These values are for these specific compositions only. Additives of any kind may alter some or all of these properties.

The data listed here fall within the normal range of product properties but they should not be used to establish specification limits nor used alone as the basis of design.

Physical properties			Units	Method
Filler/Reinforcement			weight %	ISO 3451
Density			g/cm^3	ISO 1183
Water Absorption after 24 hours (immersion @ 23°C)			%	ISO 62-1
Moisture Absorption (23°C, 50% RH) saturation			%	ISO 62-4
Mould Shrinkage flow/transverse			%	ISO/DIS 294-4:2000
Mechanical properties, measured @ standard conditioning atmosphere, ISO 291-23/50				
Tensile Strength			MPa	ISO 527-1, -2
Elongation at Break			%	ISO 527-1, -2
Tensile Modulus			MPa	ISO 527-1, -2
Flexural Strength			MPa	ISO 178
Flexural Modulus			MPa	ISO 178
Compressive Strength @ 1% deflection			MPa	ISO 604
Compressive Modulus			MPa	ISO 604
Izod impact: Notched			kJ/m^2	ISO 180/1 U
Izod impact: Un-notched			kJ/m^2	ISO 180/1 A
Charpy impact: Notched			kJ/m^2	ISO 179/1 eU
Charpy impact: Un-notched			kJ/m^2	ISO 179/1 eA
Rockwell Hardness (M-Scale)			–	ISO 2039-2
Thermal properties				
Deflection Temperature Under Load	DTUL (HDT-A) 1.8 MPa		°C	ISO 75 -1, -2
	DTUL (HDT-C) 8 MPa		°C	ISO 75 -1, -2
Vicat Softenting Temperature VST/B/50			°C	ISO 306
Coefficient of Linear Thermal Expansion	flow		$x\ 10^{-6}\ °C^{-1}$	ISO 11359 -1, -2
(20°C to 80°C)	transverse		$x\ 10^{-6}\ °C^{-1}$	ISO 11359 -1, -2
Coefficient of Linear Thermal Expansion	flow		$x\ 10^{-6}\ °C^{-1}$	ISO 11359 -1, -2
(–50°C to 200°C)	transverse		$x\ 10^{-6}\ °C^{-1}$	ISO 11359 -1, -2
Melting point			°C	ISO 3146
Electrical properties, measured @ standard conditioning atmosphere, ISO 291-23/50				
Volume Resistivity			Ω m	IEC 60093
Surface Resistivity			Ω	IEC 60093
Dielectric Strength P25/P75			kV/mm	IEC 60243 -1
Dielectric Constant, DC	Gold plated	1 MHz	–	IEC 60250
		1 GHz	–	IEC 60250
Dissipation Factor, tan δ	Gold plated	1 MHz	–	IEC 60250
		1 GHz	–	IEC 60250
Dielectric Constant, DC	unplated	1 MHz	–	IEC 60250
		10 MHz	–	IEC 60250
Dissipation Factor, tan δ	unplated	1 MHz	–	IEC 60250
		10 MHz	–	IEC 60250
Comparative Tracking Index	CTI		–	IEC 60112
	CTI M		–	IEC 60112
Flammability				
Underwriters Laboratories (www.ticona-us.com / Product Information / Agency Compliance)			class	UL 94
Limiting Oxygen Index (LOI)			% O_2	ISO 4589

	Specimen	Unfilled grade A 950	A 115	A 130	A 150
		–	15	30	50
		1.40	1.50	1.62	1.79
		–	–	0.005	–
	Pellets	0.03	–	0.04	–
	60 x 60 x 2 mm	0.0 / 0.7	0.1 / 0.4	0.2 / 0.4	0.2 / 0.4
		182	200	190	160
	ISO-Test-Specimen[1)]	3.4	3.1	2.1	1.1
		10600	12000	15000	22000
	80 x 10 x 4 mm, from ISO-Test-Specimen[1)]	158	240	280	250
		9100	12000	15000	21000
		–	85	100	140
		–	10000	14500	21000
		252	61	29	17
	80 x 10 x 4 mm, from ISO-Test-Specimen[1)]	95	45	23	12
		267	48	33	16
		95	42	26	12
		–	80	85	93
	80 x 10 x 4 mm, from ISO-Test-Specimen[1)]	187	230	235	240
		94	157	190	203
	10 x 10 x 4 mm, from ISO-Test-Specimen[1)]	145	162	160	177
	30 x 10 x 4 mm, from ISO-Test-Specimen[1)]	4	10	6	7
	and 80 x 80 x 4 mm Plates	38	18	23	19
	30 x 10 x 4 mm, from ISO-Test-Specimen[1)]	5	5	5	7
	and 80 x 80 x 4 mm Plates	33	14	20	17
		280	280	280	280
		10 [13]	10 [13]	10 [13]	10 [13]
	60 x 60 x 1 mm	10 [14]	>10 [15]	>10 [15]	>10 [15]
		47	34	31	32
	Ø 10 mm, t = 0.4 mm	–	–	5.2	–
		–	–	5.0	–
	Ø 10 mm, t = 0.4 mm	–	–	0.136	–
		–	–	0.061	–
	Ø 50 mm, t = 3.2 mm ASTM-disk	–	3.0	3.7	4.1
		–	2.9	3.2	4.0
	Ø 50 mm, t = 3.2 mm ASTM-disk	–	0.018	0.018	0.018
		–	0.008	0.008	0.008
	20 x 20 x 4 mm, from ISO-Test-Specimen[1)]	150	200	175	175
		100	<100	100	100
		V–0	V–0	V–0	V–0
		–	–	45	–

[1)] in compliance with ISO 3167

	Glass-fibre-reinforced grades				
B 130	**C 115**	**C 130**	**C 150**	**D 130 M**	**E 130 i**
30	15	30	50	30	30
1.60	1.50	1.62	1.81	1.63	1.61
0.009	–	0.005	–	–	0.005
0.08	–	0.03	–	–	–
0.0 / 0.2	0.1 / 0.5	0.2 / 0.4	0.2 / 0.4	0.2 / 0.8	0.1 / 0.5
205	160	160	150	92	150
1.0	2.5	1.9	1.0	1.5	1.6
22000	13000	15000	22000	9500	15000
300	200	245	230	124	225
20000	11500	14000	20000	10000	15000
150	82	139	152	–	93
21500	11000	22000	20500	–	14000
15	34	26	13	8	31
14	30	20	10	5	20
18	42	28	15	6	43
12	34	25	13	2	22
100	–	80	80	65	71
235	250	255	255	220	276
186	250	211	206	–	216
169	176	192	192	–	195
3	3	6	4	12	7
13	22	18	17	38	20
3	2	5	3	10	5
8	19	17	15	30	19
280	325	325	325	330	335
10^{13}	10^{12}	10^{13}	10^{13}	10^{13}	10^{13}
$>10^{15}$	$>10^{15}$	$>10^{15}$	$>10^{15}$	$>10^{15}$	10^{14}
38	35	35	28	–	32
–	–	–	–	–	6.8
–	–	–	–	–	6.3
–	–	–	–	–	0.188
–	–	–	–	–	0.036
3.5	3.1	3.7	4.1	–	3.3
3.5	3.1	3.4	4.0	–	3.2
0.008	0.020	0.018	0.018	–	0.025
0.006	0.010	0.009	0.009	–	0.020
175	150	200	200	–	200
100	–	100	150	–	125
V–0	V–0	V–0	V–0	V–0	V–0
50	–	45	–	–	45

Specimen	Glass-fibre-reinforced grades			
	H 130	**H 140**	**L 130**	**L 140**
	30	40	30	40
	1.60	1.70	1.61	1.71
	0.017	0.012	0.006	–
Pellets	–	–	–	–
60 x 60 x 2 mm	0.1 / 0.5	0.1 / 0.5	0.1 / 0.4	0.2 / 0.4
	170	160	155	130
ISO- Test- Specimen[1)]	1.5	1.2	1.6	1.1
	16500	17000	15000	17300
	245	240	230	220
80 x 10 x 4 mm, from ISO-Test-Specimen[1)]	16400	18000	15000	17400
	–	–	100	–
	–	–	14000	–
	27	27	38	26
	20	18	20	12
80 x 10 x 4 mm, from ISO-Test-Specimen[1)]	29	24	45	32
	24	14	23	14
	74	77	72	69
	298	306	235	240
80 x 10 x 4 mm, from ISO-Test-Specimen[1)]	233	251	203	204
10 x 10 x 4 mm, ISO-Test-Specimen[1)]	221	224	175	176
30 x 10 x 4 mm, from ISO-Test-Specimen[1)]	2	4	5	5
and 80 x 80 x 4 mm Plates	22	18	19	34
30 x 10 x 4 mm, from ISO-Test-Specimen[1)]	2	4	4	6
and 80 x 80 x 4 mm Plates	19	17	16	33
	330	330	300	300
	–	–	10 [12]	10 [12]
60 x 60 x 1 mm	10 [15]	10 [15]	10 [15]	10 [14]
	–	–	29	–
Ø 10 mm, t = 0.4 mm	5.6	–	–	–
	5.3	–	–	–
Ø 10 mm, t = 0.4 mm	0.221	–	–	–
	0.074	–	–	–
Ø 50 mm, t = 3.2 mm ASTM disk	–	–	3.5	3.6
	–	–	3.3	3.4
Ø 50 mm, t = 3.2 mm ASTM disk	–	–	0.024	0.020
	–	–	0.020	0.020
20 x 20 x 4 mm, from ISO-Test-Specimen[1)]	175	200	175	–
	–	–	–	–
	V–0	V–0	V–0	V–0
	50	50	45	–

[1)] in compliance with ISO 3167

	Carbon-fibre-reinforced grades		Fibre/filler-modified grades			Mineral–modified grades	
	A 230	**B 230**	**A 410**	**A 430**	**A 435**	**A 515**	**A 530**
	30	30	50	25	35	15	30
	1.49	1.50	1.84	1.50	1.62	1.52	1.65
	–	0.008	–	–	–	–	0.005
	0.06	–	0.04	–	–	–	0.06
	0.1 / 0.3	0.0 / 0.1	0.2 / 0.5	0.0 / 0.7	0.1 / 0.4	0.0 / 0.6	0.2 / 0.7
	130	200	150	160	175	175	160
	0.8	0.7	1.9	6.2	3.3	4.5	4.6
	23500	31800	20000	7000	11000	10500	11000
	220	320	225	125	210	175	180
	23000	25500	18000	7000	10500	11000	11900
	136	204	116	38	77	61	60
	23500	33000	19000	6000	10500	–	–
	16	12	23	67	33	126	27
	13	10	12	35	23	60	40
	20	15	24	86	38	100	53
	13	6	12	28	26	59	50
	83	99	76	55	55	63	–
	225	235	235	165	230	185	190
	178	186	181	89	162	103	121
	158	167	165	138	146	149	151
	2	1	7	1	0	0	10
	18	4	24	46	19	30	30
	1	–2	5	1	1	0	9
	17	3	21	41	17	27	27
	280	280	280	280	280	280	280
	10^{3}	10^{3}	10^{13}	10^{13}	10^{13}	10^{13}	10^{12}
	10^{2}	10^{2}	$> 10^{15}$	10^{15}	$> 10^{15}$	$> 10^{15}$	$> 10^{15}$
	–	–	34	36	32	40	–
	–	–	–	4.3	–	–	–
	–	–	–	4.2	–	–	–
	–	–	–	0.086	–	–	–
	–	–	–	0.040	–	–	–
	–	–	4.2	2.7	3.1	3.2	3.2
	–	–	3.9	2.9	2.8	3.1	3.3
	–	–	0.014	0.016	0.016	0.020	0.016
	–	–	0.009	0.008	0.008	0.009	0.008
	–	–	175	225	175	175	200
	<100	<100	<100	<100	<100	<100	<100
	V–0	V–0	V–0	V–0	V–0	V–0	V–0
	–	–	–	–	–	–	–

Specimen	Mineral-modified grades		Graphite-modified grade
	C 550	**E 530 i**	**A 625**
	50	30	25
	1.89	1.65	1.54
	–	0.006	–
Pellets	–	–	0.03
60 x 60 x 2 mm	0.2 / 0.7	0.2 / 1.1	0.1 / 0.5
	115	150	140
ISO- Test- Specimen[1)]	2.3	3.5	5.7
	17800	11500	10400
80 x 10 x 4 mm, from ISO-Test-Specimen[1)]	170	165	140
	17000	11700	10400
	95	–	56
	16500	–	9000
	14	22	62
80 x 10 x 4 mm, from ISO-Test-Specimen[1)]	5	20	22
	17	84	67
	4	29	11
	95	43	62
80 x 10 x 4 mm, from ISO-Test-Specimen[1)]	225	235	185
	152	–	114
10 x 10 x 4 mm, ISO-Test-Specimen[1)]	184	–	159
30 x 10 x 4 mm, from ISO-Test-Specimen[1)]	10	2	5
and 80 x 80 x 4 mm Plates	37	34	19
30 x 10 x 4 mm, from ISO-Test-Specimen[1)]	9	4	7
and 80 x 80 x 4 mm Plates[1)]	33	32	17
	325	335	280
	10^{13}	10^{10}	10^{13}
60 x 60 x 1 mm	$> 10^{15}$	$> 10^{15}$	10^{15}
	33	–	–
Ø 10 mm, t = 0.4 mm	–	5.3	–
	–	4.9	–
Ø 10 mm, t = 0.4 mm	–	0.257	–
	–	0.031	–
Ø 50 mm, t = 3.2 mm ASTM disk	4.0	–	13.0
	3.7	–	10.0
Ø 50 mm, t = 3.2 mm ASTM disk	0.010	–	0.150
	0.007	–	0.140
20 x 20 x 4 mm, from ISO-Test-Specimen[1)]	225	–	200
	<100	–	<100
	V–0	V–0	V–0
	–	40	–

[1)] in compliance with ISO 3167

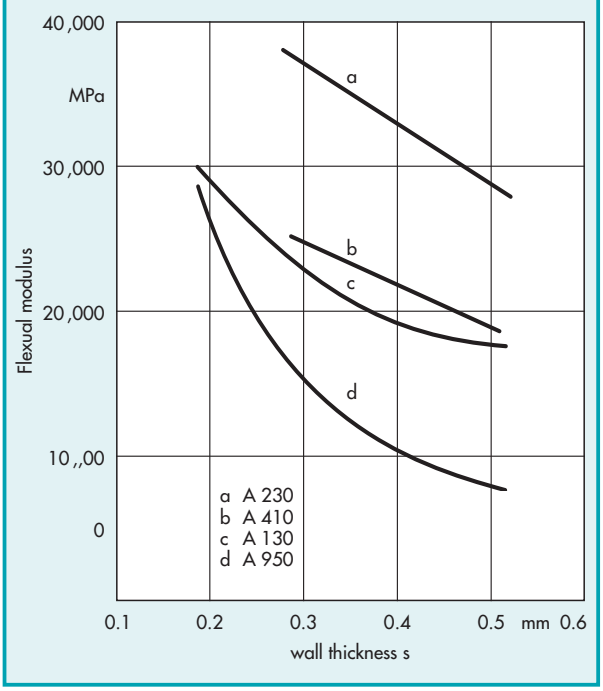
	Special grades				
	A 700	**A 725**	**C 810**	**E 820 i**	**E 820 i Pd**
	34	25	48	40	42
	1.63	1.56	1.85	1.78	1.79
	–	–	–	–	–
	–	–	0.03	–	–
	0.2 / 0.4	0.3 / 0.8	0.4 / 0.9	0.3 / 1.2	0.4 / 1.2
	140	92	100	100	90
	1.5	4.2	3.4	3.5	3.6
	14000	8100	11400	8500	8000
	220	124	133	130	120
	14000	7800	10800	9000	9000
	100	–	–	–	–
	14500	–	–	–	–
	20	22	15	45	27
	12	17	2	4	3
	15	31	25	54	35
	7	17	3	8	4
	85	44	–	–	–
	232	160	197	220	220
	178	93	119	130	–
	156	–	180	203	–
	8	10	23	17	23
	25	31	40	57	49
	8	7	21	16	21
	20	32	34	56	47
	280	280	325	335	335
	10^{3}	10^{3}	10^{13}	10^{13}	–
	10^{6}	10^{6}	10^{15}	10^{15}	–
	–	–	33	–	–
	–	–	–	7.2	6.8
	–	–	–	6.7	6.6
	–	–	–	0.165	0.163
	–	–	–	0.038	0.010
	–	–	–	–	–
	–	–	–	–	–
	–	–	–	–	–
	–	–	–	–	–
	175	–	200	175	–
	125	–	125	–	–
	V–0	V–0	V–0	V–0	V–0
	–	–	–	–	–

Grades

The comprehensive Vectra range is built around seven 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, 300, 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. The following table explains the poduct 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 in electrical and electronical components, cables and connectors for fibre optics, apparatus for chemical processes, medical equipment, automotive and mechanical engineering and the aerospace industry.

Vectra LC 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 mouldings 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 3 mm in size. Their "natural" colour is beige. The graphite-, carbon-black and carbon-fibre-filled grades are correspondingly black or anthracite in colour. The standard packaging unit is a 25 kg bag.

Vectra E 130i is supplied in microgranules of approx. 2 mm diameter in 20 kg bags.

Color masterbatches/coloration

Vectra can be coloured in order to identify or differentiate between components but it is not possible to match formulations to a colour sample or RAL colours.

Colour masterbatches with a high pigment content can be supplied in a range of colours. Masterbatches are supplied as granules and are used for melt coloration of natural Vectra grades during processing. Typically, 1 part colour masterbatch (≙ 5 %) is added to 19 parts natural granules. Lower concentrations are also possible if the colour 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 colour of the filler or reinforcing material may influence the final shade. The pigment contents may reduce mechanical properties and flowability.

Some Veeectra grades are supplied in melt-coloured black formulations with various carbon black contents. These are denoted by the suffix D-2 in the grade designation (eg A 130 D-2 or E 130 i D-2).

A and C polymers are coloured with A9500 masterbatch, Ei and H polymers are coloured with E9500i masterbatch. The following clour concentrates are available:

VA	3031	K20	white
VD	3003	K20	black
VG	3010	K20	blue
VJ	3040	K10	emerald-green
VL	3021	K10	yellow
VS	3035	K10	red

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

Vectra A 9500 VJ 3040 K10

- A: basic polymer
- 9500: masterbatch
- VJ 3040: emerald-green
- K10: mix ratio 1:10

Vectra E 9500i VJ 3031 K20

- E: basic polymer
- 9500i: masterbatch
- VJ 3031: white
- K20: mix ratio 1:20

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Notice to users:

Values shown are based on testing of laboratory test specimens and represent data that fall within the standard range of properties for natural material. These values alone do not represent a sufficient basis for any part design and are not intended for use in establishing maximum, minimum, or ranges of values for specification purposes. Colorants or other additives may cause significant variations in data values.

Properties of molded parts can be influenced by a wide variety of factors including, but not limited to, material selection, additives, part design, processing conditions and environmental exposure. Any determination of the suitability of a particular material and part design for any use contemplated by the users and the manner of such use is the sole responsibility of the users, who must assure themselves that the material as subsequently processed meets the needs their particular product or use.

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Moreover, there is a need to reduce human exposure to many materials to the lowest practical limits in view of possible adverse effects. To the extent that any hazards may have been mentioned in this publication, we neither suggest nor guarantee that such hazards are the only ones which exist. We recommend that persons intending to rely on any recommendation or to use any equipment, processing technique, or material mentioned in this publication should satisfy themselves that they can meet all applicable safety and health standards.

We strongly recommend that users seek and adhere to the manufacturer's current instructions for handling each material they use, and to entrust the handling of such material to adequately trained personnel only. Please call the telephone numbers listed below for additional technical information. Call Customer Services for the appropriate Materials Safety Data Sheets (MSDS) before attempting to process our products.

The products mentioned herein are not intended for use in medical or dental implants.

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