Celanese

The chemistry inside innovation™

MEDICAL AND PHARMACEUTICAL MATERIALS FOR INNOVATIVE HEALTHCARE PRODUCTS

Celanese Healthcare Solutions

TECHNOLOGY. DESIGN. PERFORMANCE.

Celanese offers one of the broadest ranges of healthcare materials in the industry. With over 40 years of technical expertise, Celanese is the trusted development partner and first-choice chemistry solution provider to enhance your ability to meet the demands of next generation healthcare technologies. Our innovation platforms and customized solutions provide high-quality, advanced and biocompatible polymers to help our clients innovate new healthcare technologies, mitigate risk through regulatory compliance and create eco-responsible materials.

ART OF MATERIAL SELECTION & ENGAGEMENT.

Our experts work with manufacturers and engineers to help understand, articulate and develop material needs in diverse application bases. The Celanese integrated engagement model makes it easy to innovate together with our broad portfolio, process support, part design, global footprint and continued investment into healthcare technology.

Broad Portfolio	• Covers a wide range of chemical resistance, mechanical performance and usage temperatures • Ability to customize materials to meet varying application CTQs
Process Support	• Individualized Field Technical support across our customers ecosystem (molding, extrusion, troubleshooting, testing) • End-to-end (pellet to part) support
Material Design	• Advanced computer aided engineering and design • Application and subject matter expertise (aesthetics, tribology, etc.) to support part design challenges
Global Footprint	• Ten technical and customer centers across the globe • Technical support in every time zone

REDUCE BARRIERS. ACHIEVE A NEW LEVEL OF PROVEN MATERIAL QUALITY.

THE CELANESE HEALTHCARE SERVICE PACKAGE – OUR COMMITMENT:

- Risk reduction and stability increase for customers
- Service that delivers support through the total product cycle
- Leadership in Material Quality
- Long-term supply assurance without change of formulation
- Extensive research and development capabilities
- Processing guidance and support
- Design and regulatory support
- Global regulatory approvals
- Material compliance to FDA and EU requirements
- Animal- and latex-free formulations
- Certified biocompatibility - (USP Class VI / ISO 10993, etc.)
- FDA Drug Master File
- FDA Device Master File
- Expanded Certificate of Inspection
- Application of GMP-principles

MATERIAL TECHNOLOGIES FOR NEXT GENERATION DEVICES.

VITALDOSE® CONTROLLED RELEASE EXCIPIENT EVA

Regulator-approved, easy-processing, controlled-release drug delivery

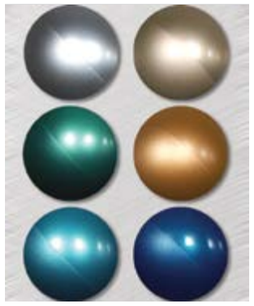
VITAL Dose® Controlled Release Excipient

HOSTAFORM® MT® SLIDEX® POM

Exceptional low friction and noise in drug delivery devices

VECTRA® LCP FOR LASER DIRECT STRUCTURING

Integration of structure and electronics in a single component for smart medical devices



CELANESE APPEARANCE POLYMERS

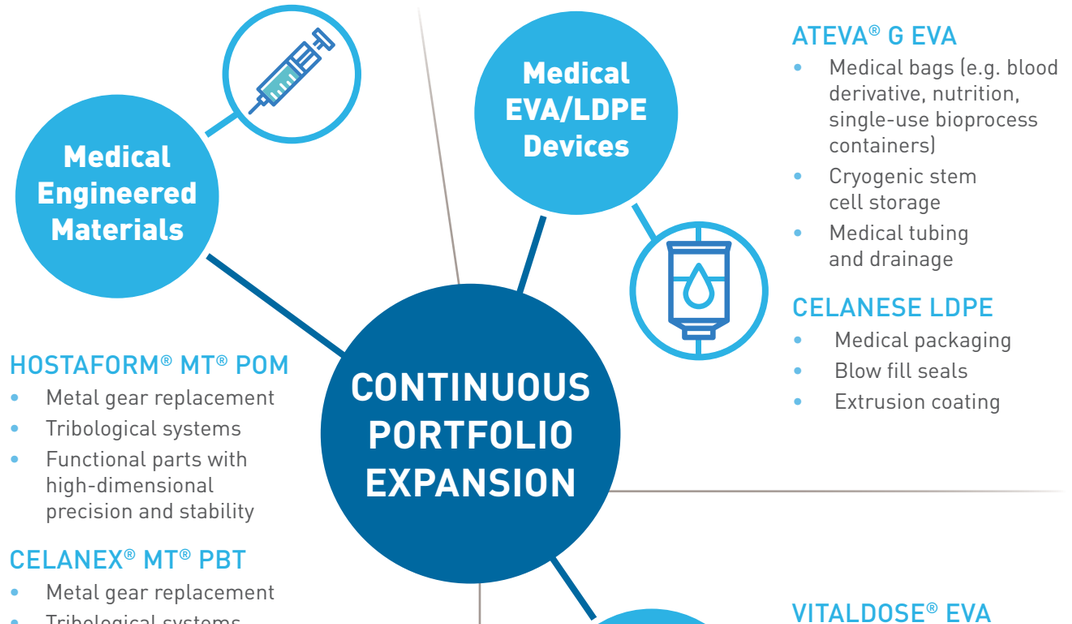
Improved haptics and appearance for medical devices

GLOBAL REACH AND CAPABILITIES

- Product and Processing Technology Development
- CAE/Design
- Color Development
- Environmental Testing
- Advanced Analytics and Research
- Physical and Mechanical Testing
- Specialty Applications
- Customized Pharmaceutical Development Support

INNOVATE WITH CELANESE, YOUR TRUSTED PARTNER FOR MEDICAL AND PHARMACEUTICAL POLYMERS.

Celanese strives to maintain one of the broadest material portfolios in the industry through constant innovation and expansion. Our existing, enhanced and select material solutions offer a wide range of mechanical, chemical and temperature properties and characteristics.



HOSTAFORM® MT® POM
- Metal gear replacement
- Tribological systems
- Functional parts with high-dimensional precision and stability

CELANEX® MT® PBT
- Metal gear replacement
- Tribological systems
- Functional parts with high-dimensional precision and stability

GUR® UHMW-PE
- Acetabular liners for total hip arthroplasty (THA)
- Tibial inserts for total knee arthroplasty
- Bearing components for shoulder and other joints

FORTRON® MT® PPS
- Surgical instrumentation
- Sterilization trays
- Metal replacement

VECTRA® MT® LCP
- Surgical instrumentation
- Sterilization trays
- Surgical stapler cartridges
- Integrated 3D circuits

ATEVA® G EVA
- Medical bags (e.g. blood derivative, nutrition, single-use bioprocess containers)
- Cryogenic stem cell storage
- Medical tubing and drainage

CELANESE LDPE
- Medical packaging
- Blow fill seals
- Extrusion coating

VITALDOSE® EVA
- Intravaginal rings
- Subcutaneous implants
- Transdermal patches

SUNETT® ACESULFAME POTASSIUM
- Cough syrup
- Pharmaceuticals
- Throat lozenges

NUTRINOVA® SORBIC ACID AND NUTRINOVA® POTASSIUM SORBATE
- Cough syrup
- Pharmaceuticals
- Throat lozenges

Celanese Engineered Materials for Medical Applications

Material Description	Typical Medical Applications	Grade	Description	Thin-Wall Sections or Long Flow Lengths	Thick-Wall Section Parts	Excellent Impact Resistance	High Strength with Flexibility	High Strength with Rigidity		High Elongation at Yield >6%	High Elongation at Yield 25%	Very Low Friction or Noise	High-Dimensional Stability	High Temperature Operation HDT >100°C	High Temperature Operation HDT >200°C	Cryogenic Operation	Sterilization ETO	Sterilization Gamma	Sterilization Steam	Food Contact EU	Food Contact US	Drug/Device Masterfile	Biocompatibility USP Class 6	Biocompatibility ISO 10993	Barrier Properties	Coloration	Injection Molding	Compression Molding	Extrusion	Film Production	Machining	Special Applications
Hostaform® MT® and Hostaform® acetal copolymer (POM)																																**Hostaform® MT® and Hostaform® acetal copolymer (POM)**
• Thermally stable • High chemical resistance • Excellent impact resistance • Suitable for repeat steam sterilization cycles • Sliding properties • High hardness and rigidity • Spring properties	• Drug delivery systems • Metal gear replacement • Snap fittings • Tribological systems • Sliding mechanisms • Clips and clamps • Functional parts with high-dimensional precision and stability • Housings • Dental instrumentation • Surgical instrumentation components • Orthopedic trial sizers	MT 2U01	Stiff flowing for extrusion and thick-walled parts	▲	+	●	+	▲		+	—	●	●	+	—	▲	+	—	●	+	+	—	+	+	●	+	+	▲	+	—	+	
		MT 8U01	Standard flow, unfilled	●	▲	●	+	▲		+	—	●	●	+	—	▲	+	—	●	+	+	+	+	+	●	+	+	▲	●	—	+	
		MT 12U01	Easy flow, unfilled	+	▲	●	+	▲		+	—	●	●	+	—	▲	+	—	●	+	+	+	+	+	●	+	+	▲	—	—	+	
		MT 12U03	Easy flow, unfilled, increased stiffness	+	▲	●	+	▲		+	—	●	●	+	—	▲	+	—	●	+	+	+	+	+	●	+	+	▲	—	—	+	
		MT 24U01	Very easy flow, unfilled	+	▲	●	+	▲		+	—	●	●	+	—	▲	+	—	●	+	+	+	+	+	●	+	+	▲	—	—	+	
		MT 8R02	Standard flow, slip modified	●	▲	▲	+	▲		+	—	+	●	—	—	▲	+	—	●	+	+	+	+	+	●	+	+	▲	●	—	+	Tribological
		MT 12R01	Easy flow, slip modified	+	▲	▲	+	▲		+	—	+	●	+	—	▲	+	—	●	+	+	+	+	+	●	+	+	▲	—	—	+	Tribological
		MT 8F01	Standard flow, PTFE modified	●	▲	▲	+	▲		+	—	+	●	+	—	▲	+	—	●	+	+	+	+	+	●	▲	+	▲	●	—	+	Tribological
		MT 8F02	Standard flow, PTFE modified	●	▲	▲	+	▲		+	—	+	●	—	—	▲	+	—	●	+	+	+	+	+	●	▲	+	▲	●	—	+	Tribological
		MT 24F01	Very easy flow, PTFE modified	+	▲	▲	+	▲		+	—	+	●	+	—	▲	+	—	●	+	+	+	+	+	●	▲	+	▲	—	—	+	Tribological
		MT 8U05	Standard flow, fluoresces under UV light	●	▲	●	+	▲		+	—	●	●	+	—	▲	+	—	●	+	+	+	+	+	●	▲	+	▲	●	—	+	UV Visibility
		MT SlideX 1203	Standard flow with tribological modification	●	▲	●	+	▲		+	—	+	●	—	—	▲	+	—	●	+	+	+	+	+	●	+	+	▲	—	—	+	Tribological
		MT SlideX 2404	Easy flow with tribological modification	+	▲	●	+	▲		+	—	+	●	—	—	▲	+	—	●	+	+	+	+	+	●	+	+	▲	—	—	+	Tribological
Celanex® MT® and Celanex® thermoplastic polyester (PBT)																																**Celanex® MT® and Celanex® thermoplastic polyester (PBT)**
• Ideal sliding and wear behavior • High-dimensional stability • Good chemical resistance to polar and non-polar solvents • Gamma-resistance up to 50kGy	• Drug delivery systems • Metal gear replacement • Functional parts with high-dimensional precision and stability • Tribological systems • Sliding mechanisms • Snap fittings • Clips and clamps	2401MT	Standard flow, unfilled	●	▲	●	+	▲		+	—	●	●	+	—	▲	+	+	●	+	+	+	+	+	●	+	+	▲	▲	▲	+	Gamma Resistant
		2402MT	Easy flow, unfilled, nucleated	+	▲	●	+	▲		+	—	●	●	+	—	▲	+	+	●	+	+	+	+	+	●	+	+	▲	▲	▲	+	Gamma Resistant
		2404MT	Standard flow, PTFE modified	●	▲	▲	+	▲		+	—	+	●	+	—	▲	+	—	●	+	+	+	+	+	●	+	+	▲	▲	▲	+	Tribological
		2405MT	Standard flow, slip modified	●	▲	●	+	▲		+	—	+	●	+	—	▲	+	+	●	+	+	+	+	+	●	+	+	▲	▲	▲	+	Gamma Resistant and Tribological
		Laser marking	Black with white marking	●	▲	●	+	▲		▲	—	●	●	+	—	▲	+	▲*	●	+	+	—	—	—	●	▲	+	▲	▲	▲	+	Laser Markable
			White with black marking	●	▲	●	+	▲		▲	—	●	●	+	—	▲	+	▲*	●	●*	●*	—	—	—	●	▲	+	▲	▲	▲	+	Laser Markable
GUR® ultra-high molecular weight polyethylene (UHMW-PE)																																**GUR® ultra-high molecular weight polyethylene (UHMW-PE)**
• Extremely high-impact strength • Low coefficient of friction • Extremely high abrasion resistance • High strength • Gamma stable for crosslinking and sterilization	• Acetabular liners for THA • Tibial inserts for TKA • Bearing components for shoulder and other joints • Endoprosthetics • Cervical disks for spine	1020	Implant grade	—	—	+	▲	▲		+	—	+	▲	—	—	+	+	+	—	+	+	+	+	+	—	▲	—	+	—	▲	+	Tribological
		1050	Implant grade	—	—	+	▲	▲		+	—	+	▲	—	—	+	+	+	—	+	+	+	+	+	—	▲	—	+	—	▲	+	Tribological
		1020-E	Implant grade + vitamin E	—	—	+	▲	▲		+	—	+	▲	—	—	+	+	+	—	+	+	+	+	+	—	▲	—	+	—	▲	+	Tribological
		1050-E	Implant grade + vitamin E	—	—	+	▲	▲		+	—	+	▲	—	—	+	+	+	—	+	+	+	+	+	—	▲	—	+	—	▲	+	Tribological
GUR® high molecular weight polyethylene (HMW-PE)																																**GUR® high molecular weight polyethylene (HMW-PE)**
• Injection moldable • Low coefficient of friction		1001	Implant grade	▲	▲	●	▲	▲		+	—	+	▲	—	—	+	+	+	—	+	+	+	+	+	—	▲	+	▲	▲	▲	+	Tribological
Fortron® MT® polyphenylene sulfide (PPS)																																**Fortron® MT® polyphenylene sulfide (PPS)**
• High-dimensional stability • Excellent chemical resistance • Heat resistance up to 240°C • Gamma, EtO and Steam Sterilizable • Suitable for repeat steam sterilization cycles	• Surgical instrumentation • Sterilization trays • Metal replacement • Nonwovens used for filtration	MT 9140L4	Standard flow, 40% glass fiber filled	●	▲	+	▲	+		—	—	▲	+	+	+	▲	+	+	+	+	+	+	+	+	▲	+	▲	▲	▲	●	
		MT 9140L6	Easy flow, 40% glass fiber filled	●	▲	+	▲	+		—	—	▲	+	+	+	▲	+	+	+	+	+	+	+	+	▲	+	▲	▲	▲	●	
Vectra® MT® liquid crystal polymer (LCP)																																
• Extremely high rigidity in thin walled designs • High-impact strength • Very high heat resistance • Suitable for repeat steam sterilization cycles • High-dimensional stability • Replication of very fine parts with extremely high precision	• Surgical instrumentation • Surgical stapler cartridges • Dental devices • Sterilization trays • Pharmaceutical packaging • Complete air and moisture barriers • Integrated 3D circuits	MT 1300	Unfilled	+	▲	▲	▲	+		—	—	●	+	+	—	+	+	+	●	+	+	+	+	+	●	+	▲	▲	▲	▲	
		MT 1310	Glass fiber filled	+	▲	▲	▲	+		—	—	▲	+	+	+	▲*	+	+	●	+*	+	+	+	+	●	+	▲	▲	▲	▲	
		MT 4310	Easy flow + glass fiber	+	▲	▲	▲	+		—	—	▲	+	+	+	▲*	+	+	●	+*	+	+	+	+	●	+	▲	▲	▲	▲	
		MT 4350	Easy flow with mineral filler	+	▲	▲	▲	+		—	—	●	+	+	+	▲*	+	+	●	+	+	+	+	●*	+	●	+	▲	▲	▲	▲	
		MT 1335	Glass fiber + PTFE	+	▲	▲	▲	+		—	—	●	+	+	+	▲*	+	—	●	+*	+	+	+	+	+	●	+	▲	▲	▲	▲	

KEY: + Excellent Match ● Good Match ▲ Possible Match — Not Appropriate *Contact us for recommendations

We Invite You to Contact Us to Discuss Your Material Requirements.

Celanese Medical Products Data Sheet

	Unit	Testing Method	HOSTAFORM® POM						
			MT 2U01	MT 8U01	MT 12U01	MT 12U03	MT 24U01	MT 8R02	MT 12R01
Property									
Density	g/cm³	ISO 1183	1.41	1.41	1.41	1.41	1.41	1.4	1.41
Volume melt flow index MVR T/2.16 (°C/Kg)	cm³/ 10 min	ISO 1133	2.2 (190°C)	8 (190°C)	12 (190°C)	12 (190°C)	24 (190°C)	8.5 (190°C)	12 (190°C)
Moisture absorption at 23°C until saturation	%	ISO 62	0.65	0.65	0.65	0.65	0.65	—	0.65
Mechanical Properties									
Tensile stress at yield (50mm/min)	MPa	ISO 527-2/1A	62	64	65	70	65	62	65
Tensile strain at yield (50mm/min)	%	ISO 527-2/1A	9	9	9	8	7.5	9	9
Tensile modulus	MPa	ISO 527-2/1A	2600	2850	2900	3100	2900	2700	2900
Charpy impact strength at 23°C	kJ/m²	ISO 179/1eU	220	180	150	120	120	—	140
Charpy notched impact strength at 23°C	kJ/m²	ISO 179/1eA	8.5	6.5	6	6	5.5	8	6.5
Thermal Properties									
Heat deflection temperature HDT/A (1.8 MPa)	°C	ISO 75-1/2	101	104	106	107	106	82	102
Heat deflection temperature HDT/B (0.45 MPa)	°C	ISO 75-1/2							
Vicat softening point VST/B/50	°C	ISO 306	151	150	151	158	151	—	151
Conformances – Food									
Consumer articles regulations and BfR recommendations*				yes	yes	yes	yes	yes	yes
FDA regulation CFR Vol. 21 § 177…/Food contact notification – FCN				2470	2470	2470	2470	2470	2470
Drug Master File (DMF)				11559	11559	11559	11559	11559	11559
Device Master File (MAF)				1079	1079	1079	1079	1079	1079
Conformances – Pharmaceuticals									
USP Class VI				yes	yes	yes	yes	yes	yes
Cytotoxicity				yes	yes	yes	yes	yes	yes
Sterilization									
Ethylene oxide				excellent	excellent	excellent	excellent	excellent	excellent
Superheated steam 121/134°C				possible	possible	possible	possible	possible	possible
Gamma radiation				not appropriate	not appropriate	not appropriate	not appropriate	not appropriate	not appropriate

*German Federal Institute for Risk Assessment

HOSTAFORM® POM						CELANEX® PBT			
MT 8F01	MT 8F02	MT 24F01	MT 8U05	MT SlideX 1203	MT SlideX 2404	2401MT	2402MT	2404MT	2405MT
Property									
1.44	1.52	1.44	1.41	1.40	1.40	1.31	1.31	1.34	1.31
8.5 (190°C)	6 (190°C)	21 (190°C)	8 (190°C)	13 (190°C)	25 (190°C)	20 (250°C)	40 (250°C)	21 (250°C)	19 (250°C)
—	0.65	—	0.65	0.6	0.6	—	—	—	—
Mechanical Properties									
58	48	58	64	58	55	60	60	56	60
9	7	—	9	12	7	4	4	7	10
2600	2500	2600	2850	2650	2550	2600	2700	2600	2500
—	60	80	180	160	160	NB	135	—	—
5.2	4	4	6.5	6	5.5	6	5	3.3	5
Thermal Properties									
102	98	100	104	93	90	55	60	55	50
						150	160	—	—
—	145	146	150	151	144	190	190	190	190
Conformances – Food									
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
2470	2470	2470	2470	2470	2470	1660	1660	1660	1660
11559	11559	11559	11559	11559	11559	10033	10033	10033	10033
1079	1079	1079	1079	1079	1079	1078	1078	1078	1078
Conformances – Pharmaceuticals									
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Sterilization									
excellent	excellent	excellent	excellent	excellent	excellent	excellent	excellent	excellent	excellent
possible	possible	possible	possible	possible	possible	possible	possible	possible	possible
not appropriate	not appropriate	not appropriate	not appropriate	not appropriate	not appropriate	excellent	excellent	not appropriate	excellent

*German Federal Institute for Risk Assessment

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Celanese Medical Products Data Sheet

	Unit	Testing Method	GUR® UHMW-PE				
			1020	1050	1020-E	1050-E	1001
Property							
Density	g/cm³	ISO 1183	0.93	0.93	0.93	0.93	0.95
Volume melt flow index MVR (190°C/21.6 Kg)	cm³/ 10 min	ISO 1133	NA	NA	NA	NA	1.1
Moisture absorption at 23°C until saturation	%	ISO 62	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Mechanical Properties							
Tensile stress at yield (50mm/min)	MPa	ISO 527-1 and 527-2	19*	19*	19*	19*	25
Tensile modulus	MPa	ISO 527-1 and 527-2	690	660	690	660	1100
Charpy impact strength at 23°C	kJ/m²	ISO 179/1eU	no break	no break	no break	no break	
Charpy double notched impact strength at 23°C	kJ/m²	ISO 11542-2	240	180	240	180	45
Thermal Properties							
Heat deflection temperature HDT/A (1.8 MPa)	°C	ISO 75-1/2	42	42	42	42	42
Vicat softening point VST/B/50	°C	ISO 306	80	80	80	80	80
Conformances – Food							
Consumer articles regulations and BfR recommendations**			yes	yes	yes	yes	yes
FDA regulation CFR Vol. 21 § 177…/ Food contact notification – FCN			1520 (2.1; 2.2)	1520 (2.1; 2.2)	1520 (2.1; 2.2)	1520 (2.1; 2.2)	1520 (2.1; 2.2)
Drug Master File (DMF)			10904	10904	10904	10904	
Device Master File (MAF)			588	588	588	588	
Conformances – Pharmaceuticals							
USP Class VI			yes	yes	yes	yes	yes
Cytotoxicity			yes	yes	yes	yes	yes
Sterilization							
Ethylene oxide			excellent	excellent	excellent	excellent	excellent
Superheated steam 121/134°C			not appropriate	not appropriate	not appropriate	not appropriate	not appropriate
Gamma radiation			excellent	excellent	excellent	excellent	excellent

	Unit	Testing Method	FORTRON® PPS	
			MT 9140L4	MT 9140L6
Property				
Density	g/cm³	ISO 1183	1.65	1.65
Reinforcing material			glass fiber	glass fiber
Concentration of reinforced materials	Weight %	ISO 3451, Part 1	40	40
Volume melt flow index MVR T/2.16 (°C/Kg)	cm³/10 min	ISO 1133	NA	NA
Moisture absorption at 23°C until saturation	%	ISO 62	0.02	0.02
Mechanical Properties				
Tensile stress at break (5mm/min)	MPa	ISO 527-2/1A	190	195
Tensile strain at break (5mm/min)	%	ISO 527-2/1A	1.8	1.9
Tensile modulus (1mm/min)	MPa	ISO 527-2/1A	14700	14700
Charpy impact strength at 23°C	kJ/m²	ISO 179/1eU	48	53
Charpy notched impact strength at 23°C	kJ/m²	ISO 179/1eU	9	10
Thermal Properties				
Heat deflection temperature HDT/B (0.45 MPa)	°C	ISO 75-1/2	280	280

*These products show no yield point. The number given is stress at 50% elongation.
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Celanese Medical Products Data Sheet

			FORTRON® PPS	
Conformances – Food			MT 9140L4	MT 9140L6
Consumer articles regulations and BfR recommendations*			yes	yes
FDA regulation CFR Vol. 21 § 177…/ Food contact notification – FCN			FCN 40	FCN 40
Drug Master File (DMF)			14844	14844
Device Master File (MAF)			1097	1097
Conformances – Pharmaceuticals				
USP Class VI			yes	yes
Cytotoxicity			yes	yes
Sterilization				
Ethylene oxide			excellent	excellent
Superheated steam 121/134°C			excellent/ excellent	excellent/ excellent
Gamma radiation			excellent	excellent

	Unit	Testing Method	VECTRA® LCP				
			MT 1300	MT 1310	MT 4310	MT 4350	MT 1335
Property							
Density	g/cm³	ISO 1183	1.40	1.62	1.61	1.74	1.62
Reinforcing material			without	glass fiber	glass fiber	mineral filled	glass/PTFE
Concentration of reinforced materials	Weight %	ISO 3451, Part 1	0	30	30	40	35
Volume melt flow index MVR T/2.16 (°C/Kg)	cm³/ 10 min	ISO 1133	NA	NA	NA	NA	NA
Moisture absorption at 23°C until saturation	%	ISO 62-4	0.003	0.04	0.03	0.005	0.002
Mechanical Properties							
Tensile stress at break (5mm/min)	MPa	ISO 527-2/1A	182	190	150	105	171
Tensile strain at break (5mm/min)	%	ISO 527-2/1A	3.4	2.1	1.6	3.2	3.3
Tensile modulus	MPa	ISO 527-2/1A	10600	15000	15000	9800	11000
Charpy impact strength at 23°C	kJ/m²	ISO 179/1eU	267	33	43	58	38
Charpy notched impact strength at 23°C	kJ/m²	ISO 179/1eA	95	26	22	6	26
Thermal Properties							
Heat deflection temperature HDT/A (1.8 MPa)	°C	ISO 75-1/2	187	235	276	230	230
Heat deflection temperature HDT/B (0.45 MPa)	°C	ISO 75-1/2	—	250	—	—	250
Vicat softening point VST/B/50	°C	ISO 306	145	160	195	195	146
Conformances – Food							
Consumer articles, regulations and BfR recommendations*			yes	yes	yes	yes	yes
FDA regulation CFR Vol. 21 § 177 Food contact notification – FCN			FCN 103	FCN 103	FCN 103	FCN 103	FCN 103
Drug Master File (DMF)			8464	8464	8464	8464	8464
Device Master File (MAF)			315	315	315	315	315
Conformances – Pharmaceuticals							
USP Class VI			yes	yes	yes	yes	yes
Cytotoxicity			yes	yes	yes	yes	yes
Sterilization							
Ethylene oxide			excellent	excellent	excellent	excellent	excellent
Superheated steam 121/134°C			possible/ possible	possible/ possible	possible/ possible	possible/ possible	possible/ possible
Gamma radiation			excellent	excellent	excellent	excellent	excellent

*German Federal Institute for Risk Assessment

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