



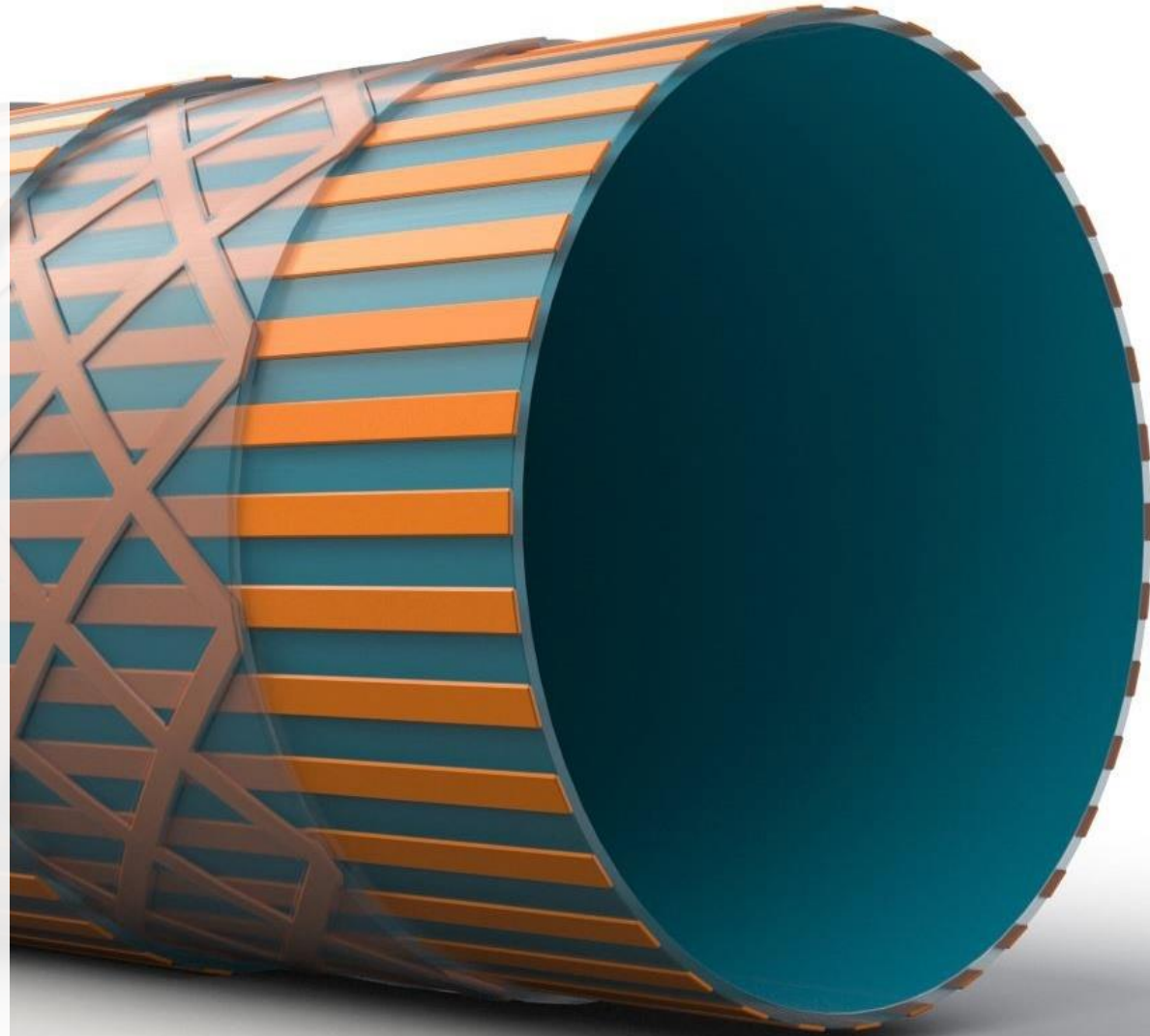
Exel Composites Tubes

FOR FORWARD THINKERS

exel
COMPOSITES

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Exel Composites - the unique tube manufacturer

- ◆ We have been in the composite tube business over 50 years, covering the whole range from bulk products to extremely complicated customized material constructions.
- ◆ In addition to our standard range, we also have thousands of tools to make customized sizes, without additional tooling investments. Our standard tubes are stocked.
- ◆ Our tubes are manufactured using multiple different reinforcements and customizable resins systems to find the best combination for your need.
- ◆ Our large production capacity, combined with our extensive engineering expertise, enables us to deliver high-output, highly optimized, and cost-effective solutions.
- ◆ We are a global leader in manufacturing pultruded and pull-wound composite tubes. Our tube manufacturing facilities are located in Europe, North America and Asia.

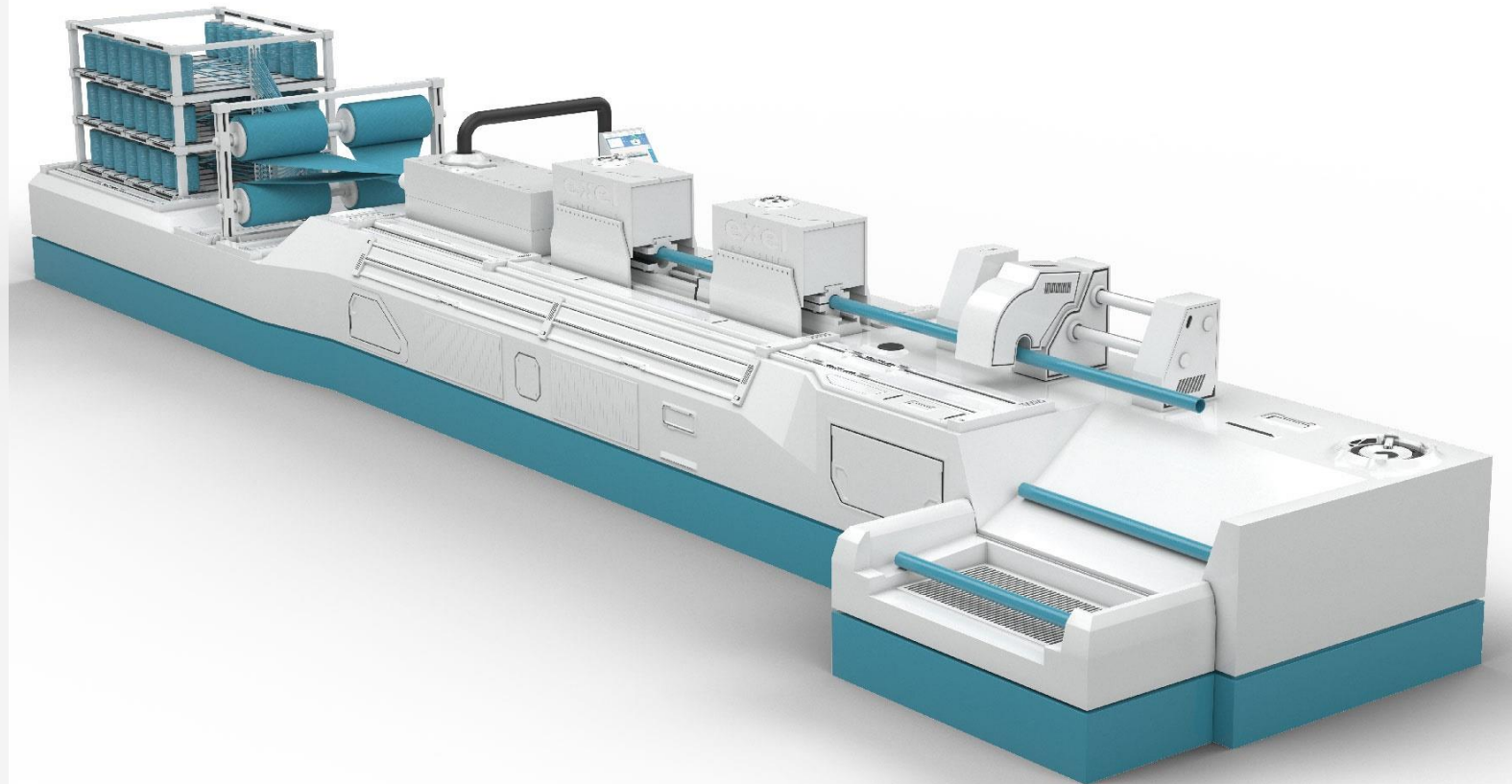




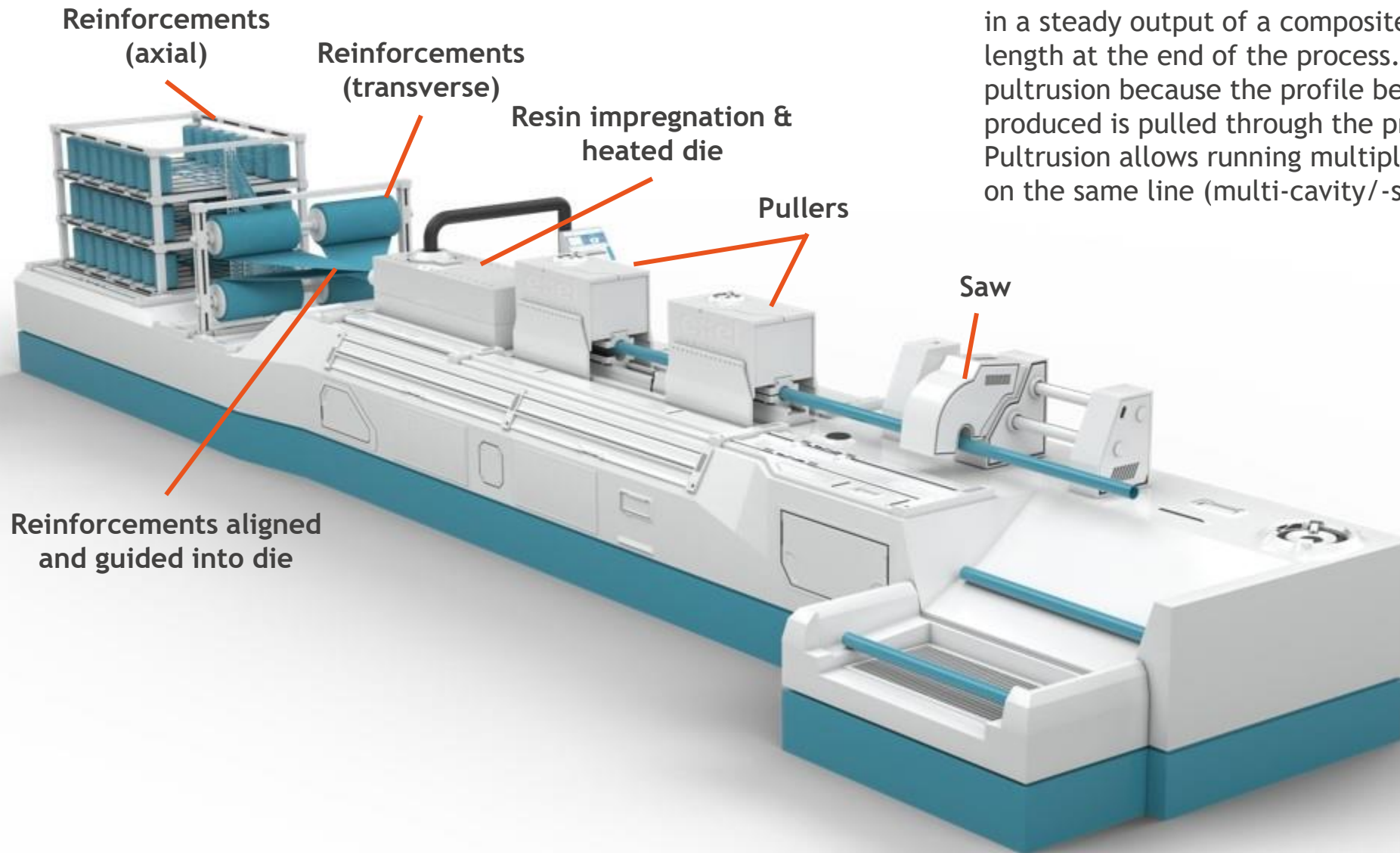
Tube manufacturing technologies

How do we make tubes?

- ◆ Exel manufactures composite tubes using continuous processes called **pultrusion and pull-winding**.
- ◆ These continuous processes provide many benefits including repeatable quality and superior surface finish straight from the machine.
- ◆ Both technologies are designed for high volume production (thousands of meters/yards) which leads to cost-efficiency with high output rates.
- ◆ As the processes are semi-automated, they are also less labor intensive compared to some other composite manufacturing technologies.



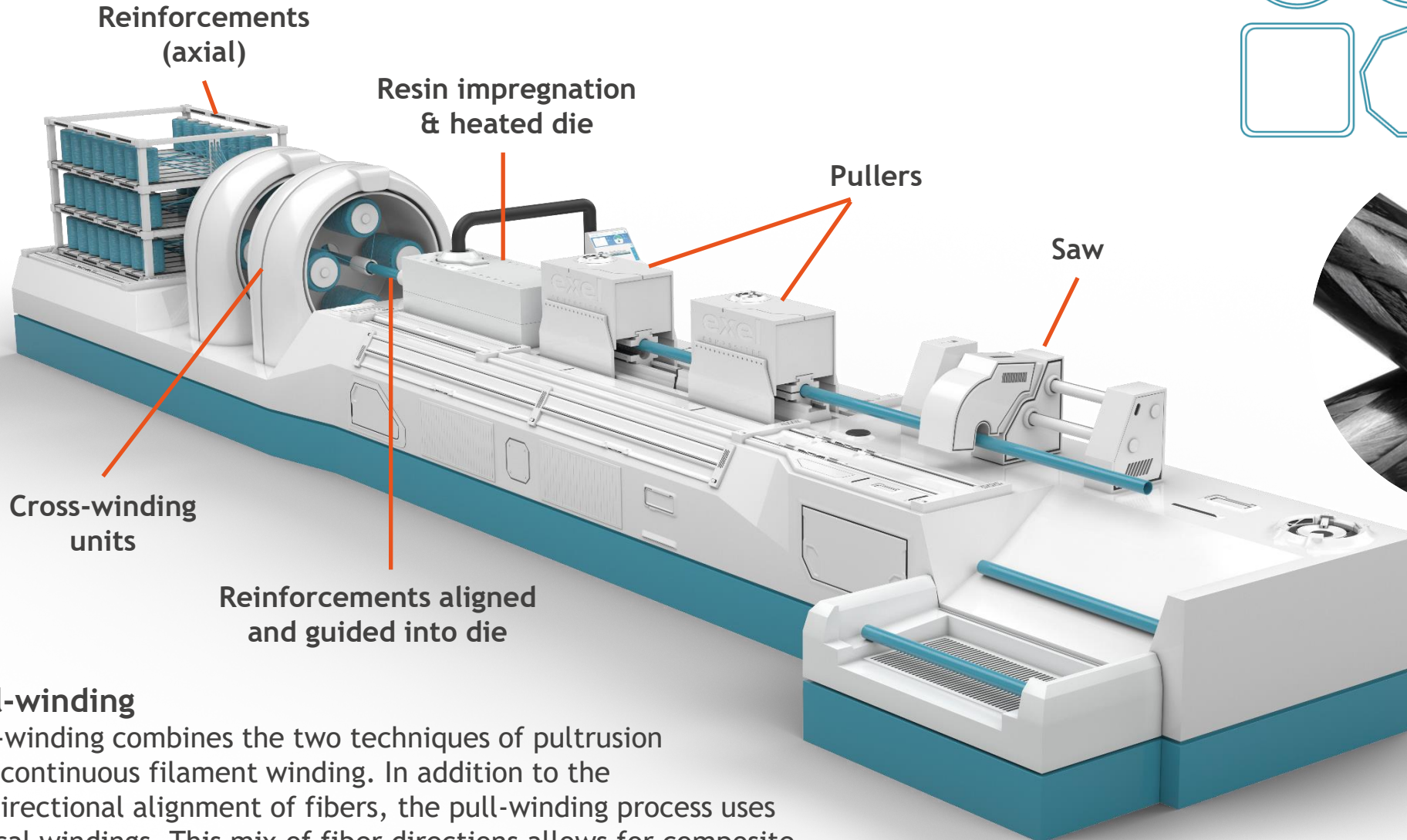
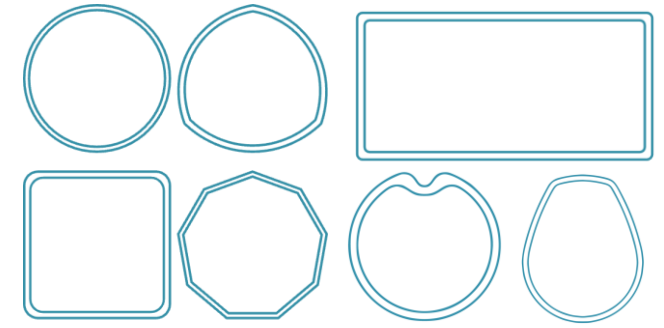
What is Pultrusion?



Pultrusion

Pultrusion is a continuous manufacturing process resulting in a steady output of a composite profile which is cut to length at the end of the process. It is called pultrusion because the profile being produced is pulled through the process by pullers. Pultrusion allows running multiple profiles at the same time on the same line (multi-cavity/-stream).

What is Pull-winding?

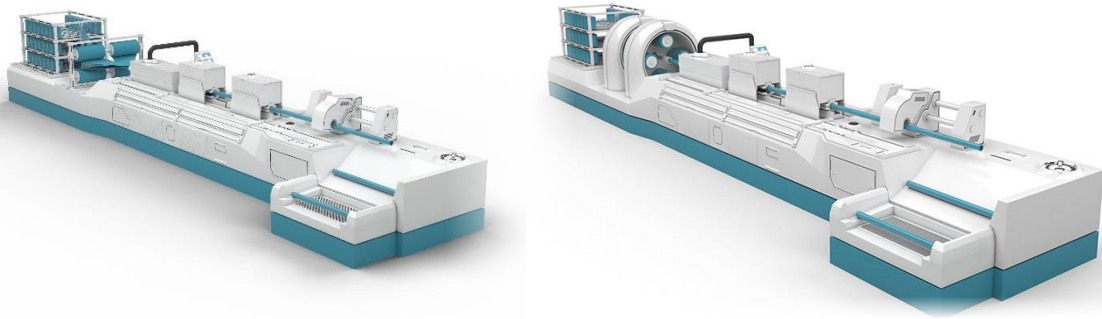


Pull-winding

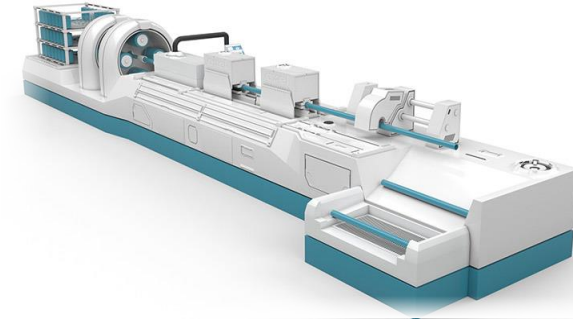
Pull-winding combines the two techniques of pultrusion and continuous filament winding. In addition to the unidirectional alignment of fibers, the pull-winding process uses helical windings. This mix of fiber directions allows for composite advantages such as thinner walls or meeting specific strength or stiffness requirements.

Why choose pull-winding?

Continuous manufacturing benefits



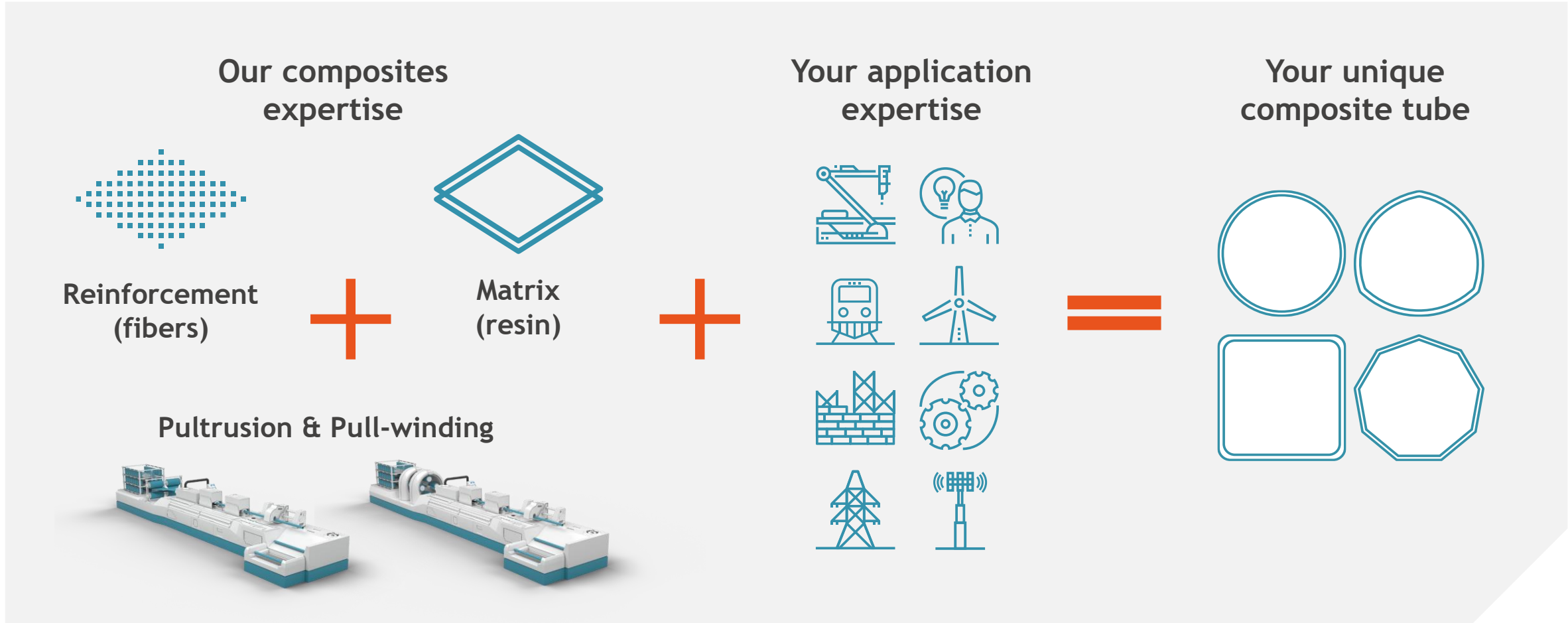
Pull-winding benefits



- Cost-efficiency in high volumes (multicavity)
- Quality consistency
- Superior surface finish straight from tool
- Customizable lengths
- High output rates
- Process is semi-automated (less labor intensive)
- On line processing possibilities like coating and lacquering

- Thin wall profiles
- Cost advantage (base form of materials)
- More possibilities for fiber placement
- Increased hoop strength and impact resistance
- More aesthetic possibilities
- Complex multilayer structures

Our philosophy of making tubes



Fiber and resin options

Choosing the right fibers

Fiber type	Main features	Mechanical properties	Cost level
Glass fiber	<ul style="list-style-type: none"> ◆ Cost-effective (E-glass) ◆ Insulating and non-corrosive ◆ Fiber density 2.56g/cm³ ◆ Typical final composite stiffness ~35GPa 	+	\$
Carbon fiber	<ul style="list-style-type: none"> ◆ Highest mechanical properties ◆ Lightweight, fiber density 1.80g/cm³ ◆ Typical final composite stiffness ~125GPa up to 200GPa 	+++++	\$\$\$ - \$\$\$\$\$
Polyester fiber	<ul style="list-style-type: none"> ◆ Lightweight, density 1.40g/cm³ ◆ Fiber can be colored for special aesthetics 	-	\$\$
Natural fibers	<ul style="list-style-type: none"> ◆ Organic/bio-based materials ◆ Lower CO²-footprint ◆ Mechanically close to glass fiber properties 	+	\$\$
Aramid	<ul style="list-style-type: none"> ◆ Increased strength ◆ Good impact and abrasion resistance 	+++	\$\$\$
Basalt	<ul style="list-style-type: none"> ◆ Enhanced temperature resistance ◆ Slightly better in mechanics than glass fiber 	++	\$\$

Choosing the right resins

Resin type	Main features	Mechanical properties	Cost level
Polyester	<ul style="list-style-type: none"> ◆ Cost-effective, most common one ◆ Basic mechanical properties ◆ Easiest to process 	+	\$
Vinylester	<ul style="list-style-type: none"> ◆ Good chemical resistance ◆ Higher strength compared to polyester ◆ Suitable for all the fibers 	++	\$\$
Epoxy	<ul style="list-style-type: none"> ◆ Higher fiber content ◆ Better stiffness and strength vs. PE/VE ◆ Adjustable glass transition temperature 	+++	\$\$\$
Polyurethane	<ul style="list-style-type: none"> ◆ Increased transverse strength, tough ◆ Allows less complex profile design ◆ Faster processing speeds 	+++	\$\$
Thermoplastics	<ul style="list-style-type: none"> ◆ Higher fiber content ◆ Recyclable ◆ Possible to postform 	++	\$\$\$
Bio-based resin	<ul style="list-style-type: none"> ◆ Polyester resin partly from bio-based sources ◆ Lower CO²-footprint ◆ No drop in mechanical properties 	+	\$\$

Surface aesthetics



Aesthetic customizations

The aesthetic appearance (color, pattern, and surface texture) are customizable. Examples include:

- ◆ RAL/Pantone colors (pigmented thoroughly)
- ◆ Custom cross-winding patterns
- ◆ Mat or fabric finishes
- ◆ Foils and textures (e.g. wood)
- ◆ Mottled appearance
- ◆ Lacquered glossy surface finish
- ◆ Matte ground or sanded surface finish
- ◆ Extruded thermoplastic coating
- ◆ Various printing methods (for logos/texts)



Wood imitation

Standard aesthetic examples



Unidirectional + veil

A veil covers the final layer of unidirectional fibers creating a less tactile, very smooth surface. The veil enables resin and pigment rich surface.

Extra protective lacquer layer can be applied during the process.



Mat + veil

The surface finish is made of a veil placed on a continuous filament mat. The print-through remains visible and the surface retains a highly tactile surface feel.

Print-through surfaces have a higher tactile feel compared to woven surfaces.



Woven fabric / multiaxial

Woven fabric provides a tactile feel and the appearance is determined by the reinforcement type and its fiber directions and weave type selected.

Protective veil can be used.



Crosswound pattern

Fibers are helically wound around the tube creating "diamond" pattern. Pattern can be changed by adjusting fiber count and angles. Multiple options for fiber material and colors available.

Exel standard tubes and general specifications

Glass fiber tubes

Glass fiber tubes are the most common tubes we manufacture. These tubes are used in various industries and applications from maintenance tools to airport masts and much more.

Main features

- ◆ Warm and pleasant surface to touch.
- ◆ Doesn't rot or corrode.
- ◆ Thermally and electrically insulating.
- ◆ Low weight and high strength compared to metals.
- ◆ Nonwoven surface finish (protective resin rich layer).
- ◆ Superior surface quality straight from the process.
- ◆ Deep and customizable colors.
- ◆ Good chemical and electrical resistance.
- ◆ Good thermal stability.
- ◆ Tailoring possibilities available like fire performance, antistatic, FDA-compliant resin options, antiviral and -bacterial treated surface.

General specification for glass fiber tubes

Manufacturing Method	Pull-winding
Structure	UCUV / UCUMV / UCUCUV
Resins	Polyester, vinylester resin
Fiber type	E-glass (S-/R-/ECR-glass)
Diameter Range O.D.	4 - 400 mm / 0.16" - 16"
Typical wall thickness	1.25 - 2 mm / 0.05" - 0.08"
Minimum wall thickness	0.50 mm / 0.02"
Colours	RAL Code
Fiber volume content	~58%
Fiber weight content	~75%
Surface finish	Smooth PES-veil
Water absorption	<2.0 w-%
Stiffness	20-40 GPa
Density	2.0 g/cm ³

Exel standard glass fiber tubes

Layup descriptions:

U = unidirectional fiber
 C = crosswound layer
 M = mat
 F = fabric
 T = tissue
 V = veil



Product GXTEL **Color** Grey
Material Glass fiber - polyester resin
Layup UCUV **Surface** Unidirectional + veil

Item code	OD/ID		Weight		Stiffness	
	[mm]	[in]	[g/m]	[lb/ft]	[GPa]	[msi]
40042245	18/15	0.709/0.591	155	0.104	40	5.8
40042246	22/18	0.866/0.709	250	0.168	40	5.8
40042247	22/19.5	0.866/0.768	165	0.111	40	5.8
40042248	26/23	1.024/0.906	230	0.155	40	5.8
40042249	30/27	1.181/1.063	270	0.181	40	5.8
40042250	34/31	1.339/1.220	305	0.205	40	5.8
40042251	38/35	1.496/1.378	340	0.228	40	5.8
40042252	42/39	1.654/1.535	380	0.255	40	5.8
40042253	46/43	1.811/1.693	415	0.279	40	5.8
40042254	50/47	1.969/1.850	455	0.306	40	5.8
40042255	54/51	2.126/2.008	485	0.326	40	5.8



Product Universal **Color** Marble grey
Material Glass fiber - polyester resin
Layup UCUMV **Surface** Mat + veil

Item code	OD/ID		Weight		Stiffness	
	[mm]	[in]	[g/m]	[lb/ft]	[GPa]	[msi]
40017734	16.5/12.5	0.630/0.492	160	0.108	35	5.1
40009763	23/18	0.906/0.709	320	0.215	35	5.1
40009801	23/19.5	0.906/0.768	230	0.155	35	5.1
40009764	30/26	1.181/1.024	350	0.235	35	5.1
40009765	37/33	1.457/1.299	430	0.289	35	5.1
40009766	44/40	1.732/1.575	520	0.349	35	5.1
40009767	51/47	2.008/1.850	590	0.396	35	5.1
40009805	58/54	2.283/2.126	690	0.464	35	5.1
40014296	65/61	2.559/2.402	760	0.511	35	5.1



Product Universal **Color** Yellow
Material Glass fiber - vinylester resin
Layup UCUMV **Surface** Mat + veil

Item code	OD/ID		Weight		Stiffness	
	[mm]	[in]	[g/m]	[lb/ft]	[GPa]	[msi]
40100061	16.5/12.5	0.630/0.492	160	0.108	35	5.1
40009758	23/18	0.906/0.709	320	0.215	35	5.1
40033461	23/19.5	0.906/0.768	230	0.155	35	5.1
40009759	30/26	1.181/1.024	350	0.235	35	5.1
40009760	37/33	1.457/1.299	430	0.289	35	5.1
40009761	44/40	1.732/1.575	520	0.349	35	5.1
40009762	51/47	2.008/1.850	590	0.396	35	5.1
40009788	58/54	2.283/2.126	690	0.464	35	5.1
40014297	65/61	2.559/2.402	760	0.511	35	5.1

Carbon fiber tubes

Our carbon fiber tubes combine high performing fibers and resins to create composites with superior mechanical properties. They are used in applications where ultimate lightweight and high mechanical performance are needed such as drones, transportation and high-reach cleaning.

Main features

- ◆ Superior strength and stiffness. Multiple times stronger than steel/aluminum.
- ◆ Lower weight compared to full glass structure. 80% lighter than steel.
- ◆ Excellent strength-to-weight -ratio.
- ◆ Superior surface quality straight from the process, no post-processing.
- ◆ Customizable surface patterns by adjusting the fiber angles.
- ◆ Thermally carbon products are very stable.
- ◆ Typical color is black.
- ◆ Carbon is electrically conductive.

General specification for carbon fiber tubes

Manufacturing Method	Pull-winding
Structure	UCUV / UCUMV / UCUC
Resins	Epoxy resin, vinylester
Fiber type	HS-carbon/HM-carbon (UHM)
Diameter Range O.D.	4 - 400 mm / 0.16" - 16"
Typical wall thickness	1.0 - 1.5mm / 0.04" - 0.06"
Minimum wall thickness	0.50mm / 0.02"
Color	Black
Fiber volume content	~63%
Fiber weight content	~80%
Surface finish	Plain/diamond pattern
Water absorption	<0.5 w-%
Stiffness	~125-175 GPa
Density	1.55 g/cm ³

Exel standard carbon fiber tubes

Layup descriptions:

U = unidirectional fiber
 C = crosswound layer
 M = mat
 F = fabric
 T = tissue
 V = veil



Product CXTEL **Color** Black
Material HS/HM carbon fiber - epoxy resin
Layup UCUTV **Surface** CF-mat + veil

Item code	OD/ID		Weight		Stiffness	
	[mm]	[in]	[g/m]	[lb/ft]	[GPa]	[msi]
40042267	18/15	0.709/0.591	125	0.084	125	18.1
40042268	22/18	0.866/0.709	200	0.134	125	18.1
40042269	22/19.5	0.866/0.768	130	0.087	125	18.1
40042270	26/23	1.024/0.906	185	0.124	125	18.1
40042271	30/27	1.181/1.063	215	0.144	125	18.1
40061300	34/31	1.339/1.220	245	0.165	125	18.1
40061301	38/35	1.496/1.378	280	0.188	125	18.1
40061302	42/39	1.654/1.535	310	0.208	125	18.1
40042275	46/43	1.811/1.693	335	0.225	125	18.1
40042276	50/47	1.969/1.850	365	0.245	125	18.1
40042277	54/51	2.126/2.008	395	0.265	125	18.1



Product CXTEL-V2 **Color** Black
Material HM carbon fiber - epoxy resin
Layup UCUCV **Surface** Crosswound pattern

Item code	OD/ID		Weight		Stiffness	
	[mm]	[in]	[g/m]	[lb/ft]	[GPa]	[msi]
40100023	18/16	0.709/0.630	85	0.057	175	25.4
40042278	22/19.5	0.866/0.768	125	0.084	175	25.4
40042279	26/24	1.024/0.768	120	0.081	175	25.4
40042280	30/28	1.181/1.102	140	0.094	175	25.4
40042281	34/32	1.339/1.260	160	0.108	175	25.4
40042282	38/36	1.496/1.417	180	0.121	175	25.4
40042283	42/40	1.654/1.575	200	0.134	175	25.4
40042284	46/43.5	1.811/1.713	270	0.181	175	25.4
40042285	50/47.5	1.969/1.870	295	0.198	175	25.4
40042286	54/51.5	2.126/2.028	320	0.215	175	25.4

Hybrid tubes

Our hybrid tubes mix two or more fibers to create optimized structures. It allows adjusting mechanical properties both in axial and transverse directions to match the exact customer needs. Hybrid tubes are used wherever optimized solutions are needed like sports equipment, tripods or automotive.

Main features

- ◆ Fiber mixing key to optimized stiffness/strength properties.
- ◆ Cost-optimization through fiber selection.
- ◆ Nonwoven surface for resin rich protective layer.
- ◆ Good surface quality straight from the tool.
- ◆ Insulative layers possible (to prevent galvanic corrosion).
- ◆ Customizable colors through pigmented resin.
- ◆ Good chemical and electrical resistance.
- ◆ Many tailoring possibilities like fire performance and antistatic surface.
- ◆ Possibility to use FDA compliant resin system.



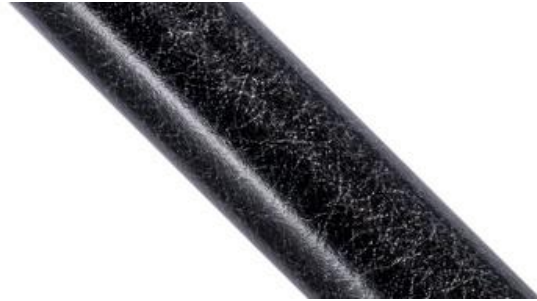
General specification for hybrid tubes

Manufacturing Method	Pull-winding
Structure	UCUV / UCUCUV / UCUFV
Resins	Poly-/vinylester or epoxy resin
Fiber type	Glass/polyester/HS-carbon/HM-carbon/flax
Diameter Range O.D.	4 - 400 mm / 0.16" - 16"
Typical wall thickness	1.0 - 1.5mm / 0.04" - 0.06"
Minimum wall thickness	0.50mm / 0.02"
Colors	RAL code/black
Fiber volume content	~58%
Fiber weight content	~75%
Surface finish	Plain/fabric/mat/diamond
Water absorption	<0.5-2.0 w-%
Stiffness	~35-150 GPa
Density	1.55-2.00 g/cm ³

Exel standard hybrid tubes

Layup descriptions:

U = unidirectional fiber
 C = crosswound layer
 M = mat
 F = fabric
 T = tissue
 V = veil



Product Universal **Color** Black
Material Carbon/glass fiber + vinylester resin
Layup UCUMV **Surface** Mat + veil

Item code	OD/ID		Weight		Stiffness	
	[mm]	[in]	[g/m]	[lb/ft]	[GPa]	[msi]
40100062	16.5/12.5	0.630/0.492	130	0.087	90	13.1
40100063	23/18	0.906/0.709	260	0.175	90	13.1
40009792	23/19.5	0.906/0.768	190	0.128	90	13.1
40009793	30/26	1.181/1.024	290	0.195	90	13.1
40009794	37/33	1.457/1.299	360	0.242	90	13.1
40009795	44/40	1.732/1.575	420	0.282	90	13.1
40009796	51/47	2.008/1.850	500	0.336	90	13.1
40009797	58/54	2.283/2.126	560	0.376	90	13.1
40014276	65/61	2.559/2.402	640	0.430	90	13.1

Product HXTEL **Color** Black
Material Carbon/glass fiber + vinylester resin
Layup UCUFV **Surface** Fabric + veil

Item code	OD/ID		Weight		Stiffness	
	[mm]	[in]	[g/m]	[lb/ft]	[GPa]	[msi]
40061247	18/15	0.709/0.591	130	0.087	80	11.6
40061248	22/18	0.866/0.709	205	0.138	80	11.6
40061249	22/19.5	0.866/0.768	135	0.091	80	11.6
40061250	26/23	1.024/0.906	190	0.128	80	11.6
40061251	30/27	1.181/1.063	220	0.148	80	11.6
40061252	34/31	1.339/1.220	250	0.168	80	11.6
40061253	38/35	1.496/1.378	280	0.188	80	11.6
40061254	42/39	1.654/1.535	315	0.212	80	11.6
40061255	46/43	1.811/1.693	340	0.228	80	11.6
40061256	50/47	1.969/1.850	370	0.249	80	11.6
40061257	54/51	2.126/2.008	400	0.269	80	11.6

Product HXTEL-V2 **Color** Black (diamond pattern)
Material HS carbon/PES fiber + epoxy resin
Layup UCUCC **Surface** Crosswound pattern

Item code	OD/ID		Weight		Stiffness	
	[mm]	[in]	[g/m]	[lb/ft]	[GPa]	[msi]
40042235	18/15	0.709/0.591	125	0.084	110	16.0
40042236	22/19.5	0.866/0.768	130	0.087	110	16.0
40042237	26/23.5	1.024/0.925	150	0.101	110	16.0
40042238	30/27.5	1.181/1.083	175	0.118	110	16.0
40042239	34/31.5	1.339/1.240	200	0.134	110	16.0
40042240	38/35.5	1.496/1.398	225	0.151	110	16.0
40042241	42/39.5	1.654/1.555	250	0.168	110	16.0
40042242	46/43.5	1.811/1.713	275	0.185	110	16.0
40042243	50/47.5	1.969/1.870	300	0.202	110	16.0
40042244	54/51.5	2.126/2.028	325	0.218	110	16.0

Logistics information

Logistics information

Our tube production facilities are located in Europe, USA and Asia.

Typical lead times:

▶ Standard tubes

Few days to weeks to ship from PO confirmation depending on stock availability and volumes. Samples available on demand.

▶ Customized tubes:

6 - 12 weeks to ship from PO, depending on the complexity and tooling availability (thousands of tools available). To be confirmed at the placement of order.

For more information and contacting us, please visit our website exelcomposites.com

Or use the QR-code:



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