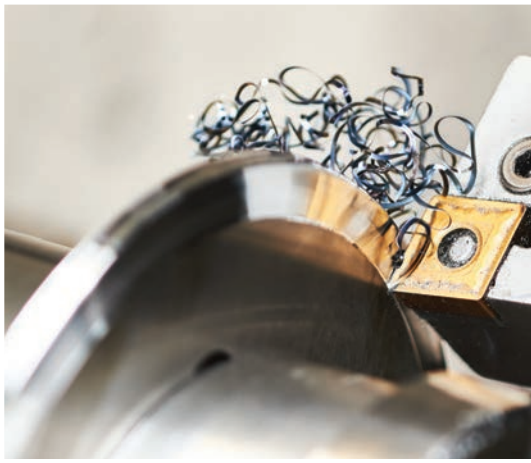


Seamless Stainless Hollow Bar & Mechanical Tubing in Standard & IMCO® grades

Hollow Bar advantages for component manufacturing industries

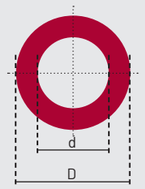
Hollow Bar and Mechanical Tubing provide an economic and efficient means of supplying high quality raw material stock for the manufacture of radially machined components; the sensible alternative to the use of solid bar.

Hollow Bar minimizes material wastage and reduces the total machining requirements by avoiding the initial drilling operation.

Typical manufacturers that use stainless steel Hollow Bar to make components used in:

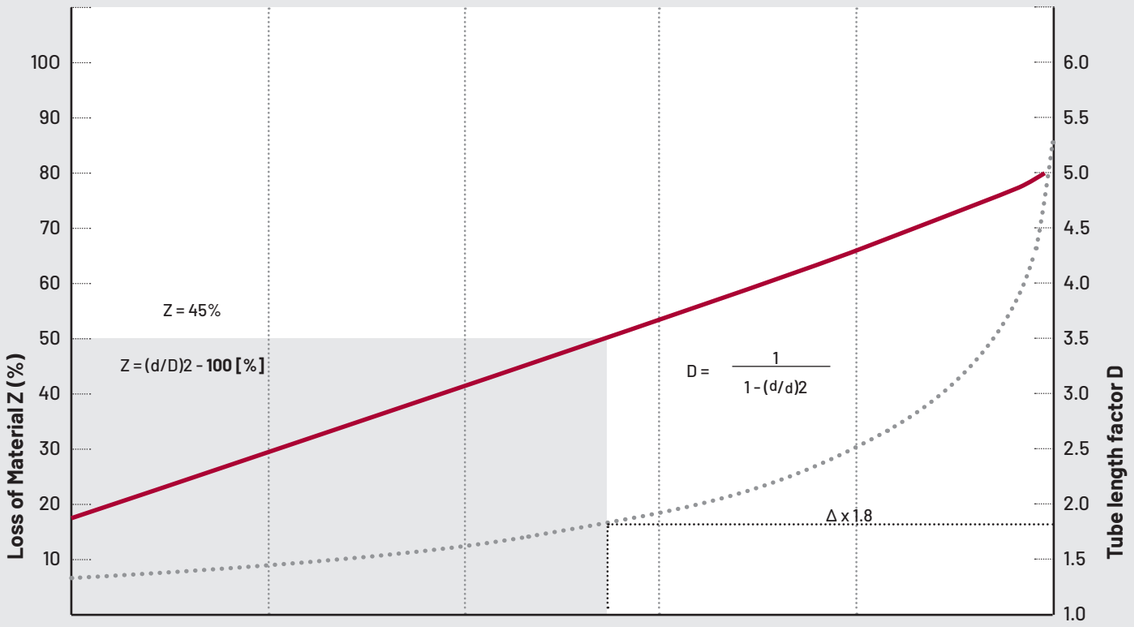
- general engineering
- chemical & petrochemical plants
- automotive production
- paper production plants
- textile production plants
- food production equipment
- anti-friction and slide bearing production

Example:
D = 75 mm
d = 50 mm
d/D = 0.67
Z = 45 %
D = 1.8



Typical material savings

The red line represents the loss of material 'Z' involved when turning a solid round into a Mechanical Tube. Here 45 % of the solid round must be removed for this purpose. The dotted line illustrates the tube length factor 'D', which indicates the extra length available for the mechanical parts production as opposed to solid rounds of the same weight. The example shows a 1.8-fold tube length increase, which means that almost twice as many parts can be made from the tubular weight of material.

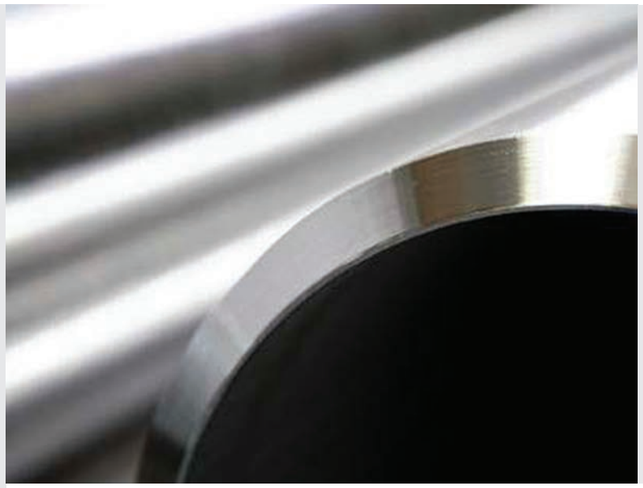


Machining allowances & production tolerances

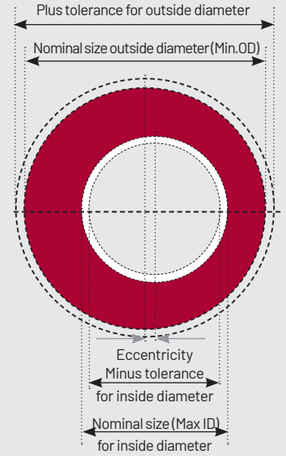
Hollow Bar is manufactured in the size ranges most frequently required by mechanical engineering manufacturing companies. However, in the case of Hollow Bar, the tolerance range for the outside diameter lies in the plus range, and for the inside diameter in the minus range. The wall thickness tolerance is determined by the degree of centre offset; this is due to the effect of the tolerance for the outside and inside diameter, the wall thickness and the centre offset. (See diagram below.)

In the case of Mechanical Tubing to ASTM A 511, the outside diameter and the wall dimensions generally lie in the centre of the tolerance range. Thus, when ordering product for machining it is important to take into account the differences in the tolerances between the Hollow Bar and the ASTM A 511 Mechanical Tubing specifications.

In most cases the machining set up is based on centring the outside diameter.



Standard Hollow Bar Tolerances



The diagram gives a general idea of the production related tolerances for Hollow Bar

Outside diameter range	Dimensional tolerances			
mm	For the outside diameter | D	For the inside diameter | d	For eccentricity (centre offset) | E	For out-of-straightness | h
32 # D # 275	-0/+2% (min. 1 mm)	+0/-2% (min. 1 mm)	10%	1 mm/m

Outside diameter range	Machining allowances	
mm	For the outside diameter	For the inside diameter
32 # D # 70	1.0 mm	1.0 mm
70 # D # 132	1.0 mm	1.0 mm
132 # D # 200	1.0 mm	2.0 mm
200 # D # 275	1.0 mm	2.0 mm

Note: The machining allowances are recommended minimum values and are related to short-length mechanical parts (L<2.5 x D, max. 250mm). Machining allowances for longer parts or special machining procedures can be customised. Machining allowances when ordering Mechanical Tubing to ASTM A 511are different to those for Hollow Bar and are detailed on page 9.

Hollow Bar – Standard sizes

Rough size and weight			Finish-turned sizes			
			Externally centred		Internally centred	
Nominal outside diameter mm	Nominal inside diameter mm	Theoretical weight kg/m	Max. outside diameter mm	Min. inside diameter mm	Max. outside diameter mm	Min. inside diameter mm
32	20	4.21	31.0	22.0	30.1	21.0
32	16	5.05	31.0	18.2	30.0	17.0
36	25	4.56	35.0	26.9	34.2	26.0
36	20	5.90	35.0	22.1	34.0	21.0
36	16	6.75	35.0	18.3	34.0	17.0
40	28	5.51	39.0	29.9	38.1	29.0
40	25	6.45	39.0	27.0	38.1	26.0
40	20	7.79	39.0	22.2	38.0	21.0
45	32	6.71	44.0	34.0	43.0	33.0
45	30	7.45	44.0	32.0	43.0	31.0
45	28	8.14	44.0	30.2	42.9	29.0
45	20	10.43	44.0	22.3	43.0	21.0
50	36	8.02	49.0	37.9	48.1	37.0
50	32	9.65	49.0	34.2	47.9	33.0
50	28	11.09	49.0	30.3	47.9	29.0
50	25	12.04	49.0	27.3	48.0	26.0
56	40	10.17	55.0	42.1	54.0	41.0
56	36	12.00	55.0	38.2	53.9	37.0
56	28	15.07	55.0	30.4	53.8	29.0
56	25	16.02	55.0	27.6	53.7	26.0
63	50	9.96	62.0	51.9	61.0	51.0
63	45	12.82	62.0	47.2	60.8	46.0
63	40	15.39	62.0	42.4	60.8	41.0
63	36	17.21	62.0	38.4	60.9	37.0
63	32	18.84	62.0	34.6	60.7	33.0
71	56	12.82	70.0	57.9	69.0	57.0
71	45	19.53	70.0	47.3	68.9	46.0
71	36	23.91	70.0	38.6	68.7	37.0
75	60	13.66	74.0	61.9	73.0	61.0
75	50	20.32	74.0	52.2	72.9	51.0
75	40	25.75	74.0	42.6	72.7	41.0
80	63	16.28	79.0	65.1	77.9	64.0
80	50	25.17	79.0	52.5	77.7	51.0
80	45	28.04	79.0	47.6	77.7	46.0
80	40	30.60	79.0	42.9	77.5	41.0
85	45	33.20	84.0	47.8	82.5	46.0
90	75	16.87	89.0	77.0	88.9	76.0
90	71	20.41	89.0	73.0	88.0	72.0
90	63	26.91	89.0	65.2	87.8	64.0
90	56	31.96	89.0	58.7	87.6	57.0
90	50	35.81	89.0	52.8	87.5	51.0
95	75	22.65	94.0	77.0	92.9	76.0
95	67	29.55	94.0	69.3	92.8	68.0
95	50	41.59	94.0	53.1	92.4	51.0

Hollow Bar & Mechanical Tubing

Hollow Bar – Standard sizes

Rough size and weight			Finish-turned sizes			
			Externally centred		Internally centred	
Nominal outside diameter mm	Nominal inside diameter mm	Theoretical weight kg/m	Max. outside diameter mm	Min. inside diameter mm	Max. outside diameter mm	Min. inside diameter mm
100	80	24.10	99.0	82.0	97.9	81.0
100	71	32.30	99.0	73.3	97.8	72.0
100	63	38.80	99.0	65.6	97.6	64.0
100	56	43.85	99.0	59.0	97.4	57.0
106	90	21.61	105.0	91.9	103.9	91.0
106	80	31.83	105.0	82.1	103.9	81.0
106	71	40.04	105.0	73.5	103.7	72.0
106	63	46.54	105.0	65.9	103.4	64.0
106	56	51.58	105.0	59.3	103.2	57.0
112	90	29.79	111.0	92.1	109.8	91.0
112	80	40.01	111.0	82.5	109.6	81.0
112	71	48.22	111.0	73.8	109.5	72.0
112	63	54.72	111.0	66.2	109.2	64.0
118	90	38.43	117.0	92.2	115.8	91.0
118	80	48.65	117.0	82.6	115.6	81.0
118	71	56.85	117.0	74.1	115.3	72.0
118	63	63.36	117.0	66.5	115.0	64.0
125	100	37.65	124.0	102.0	122.9	101.0
125	90	49.07	124.0	92.4	122.7	91.0
125	80	59.29	124.0	82.9	122.3	81.0
125	71	67.50	124.0	74.4	122.0	72.0
132	106	41.48	131.0	108.0	129.8	107.0
132	90	60.33	131.0	92.7	129.4	91.0
132	80	70.55	131.0	83.3	129.1	81.0
132	71	78.75	131.0	74.8	128.8	72.0
140	112	47.23	139.0	114.1	137.8	113.0
140	100	62.52	139.0	102.6	137.5	101.0
140	90	73.39	139.0	93.2	137.1	91.0
140	80	84.17	139.0	83.7	136.8	81.0
150	125	46.85	149.0	126.9	147.9	126.0
150	112	65.37	149.0	114.5	147.6	113.0
150	106	73.24	149.0	108.8	147.3	107.0
150	95	86.53	149.0	98.4	147.0	96.0
150	80	102.31	149.0	84.2	146.4	81.0
160	132	55.43	159.0	134.0	157.7	133.0
160	122	70.70	159.0	124.4	157.5	123.0
160	112	84.77	159.0	115.0	157.2	113.0
160	90	111.49	159.0	94.2	156.4	91.0
170	140	63.00	169.0	143.1	167.6	142.0
170	130	79.23	169.0	132.5	167.5	131.0
170	118	97.12	169.0	121.1	167.1	119.0
170	110	108.09	169.0	113.5	166.9	111.0
170	106	113.28	169.0	109.8	166.6	107.0
170	100	120.72	169.0	104.1	166.4	101.0

Rough size and weight			Finish-turned sizes Externally centred		Internally centred	
Nominal outside diameter mm	Nominal inside diameter mm	Theoretical weight kg/m	Max. outside diameter mm	Min. inside diameter mm	Max. outside diameter mm	Min. inside diameter mm
170	140	64.19	169.0	143.1	167.6	142.0
170	130	80.73	169.0	132.5	167.5	131.0
170	118	98.96	169.0	121.1	167.1	119.0
170	106	115.43	169.0	109.8	166.6	107.0
170	100	123.00	169.0	104.1	166.4	101.0
180	150	67.47	179.0	153.1	177.6	152.0
180	140	84.90	179.0	143.4	177.5	142.0
180	130	101.13	179.0	133.0	177.1	131.0
180	125	108.80	179.0	128.3	176.9	126.0
180	100	142.62	179.0	104.6	176.1	101.0
190	160	71.98	189.0	163.0	187.6	162.0
190	150	90.62	189.0	153.4	187.4	152.0
190	140	108.05	189.0	143.9	187.1	142.0
190	132	121.14	189.0	135.4	186.8	133.0
190	106	158.34	189.0	110.8	185.9	107.0
200	170	76.55	199.0	173.0	197.6	172.0
200	160	96.39	199.0	163.4	197.4	162.0
200	150	115.02	199.0	153.9	197.1	152.0
200	140	132.46	199.0	144.5	196.7	142.0
200	112	174.88	199.0	117.0	195.8	113.0
212	180	86.44	211.0	183.1	209.5	182.0
212	170	107.48	211.0	173.4	209.4	172.0
212	130	179.62	211.0	134.6	208.0	131.0
224	180	119.18	223.0	183.5	221.3	182.0
224	170	140.22	223.0	174.0	220.9	172.0
224	160	160.09	223.0	164.6	220.6	162.0
224	140	199.84	223.0	145.7	219.9	142.0
236	190	131.47	235.0	193.5	233.2	192.0
236	170	174.76	235.0	174.6	232.5	172.0
236	150	213.24	235.0	155.7	231.8	152.0
240	170	186.67	239.0	174.8	236.4	172.0
250	200	150.60	249.0	203.7	247.0	202.0
250	190	174.05	249.0	194.5	247.0	192.0
250	150	255.81	249.0	154.5	247.0	152.0
275	200	150.60	274.0	203.6	273.0	202.0

Standard sizes - Other dimensions can be supplied on agreement.

All the above dimensions, including the tables on pages 6 & 7, are for maximum length L < 2.5 x D, max. 250 mm.

The weight kg/m for molybdenum grades (DMV 316 LMC, DMV 316 TI, DMV 316 LMMC) has to be increased by approx. + 1 %

Hollow Bar & Mechanical Tubing

Mechanical Tubing to ASTM A 511

Standard sizes							
Outside diameter inches	Wall thickness inches	Outside diameter mm	Wall thickness mm	Outside diameter inches	Wall thickness inches	Outside diameter mm	Wall thickness mm
2.00	0.188 to 0.500	50.80	4.78 to 12.70	6.00	0.250 to 1.000	152.40	6.35 to 25.40
2.25	0.188 to 0.750	57.15	4.78 to 19.05	6.25	0.250 to 1.500	158.75	6.35 to 38.10
2.50	0.188 to 0.750	63.50	4.78 to 19.05	6.50	0.250 to 1.500	165.10	6.35 to 38.10
2.75	0.188 to 0.875	69.85	4.78 to 22.23	6.75	0.375 to 1.500	171.45	9.53 to 38.10
3.00	0.188 to 0.875	76.20	4.78 to 22.23	7.00	0.375 to 1.500	177.80	9.53 to 38.10
3.12	0.188 to 0.875	79.38	4.78 to 22.23	7.25	0.375 to 1.500	184.15	9.53 to 38.10
3.25	0.188 to 0.875	82.55	4.78 to 22.23	7.50	0.375 to 1.500	190.50	9.53 to 38.10
3.50	0.188 to 0.875	88.90	4.78 to 22.23	7.75	0.375 to 1.500	196.85	9.53 to 38.10
3.75	0.250 to 0.875	95.25	6.35 to 22.23	8.00	0.375 to 1.500	203.20	9.53 to 38.10
4.00	0.250 to 0.875	101.60	6.35 to 22.23	8.25	0.375 to 1.500	209.55	9.53 to 38.10
4.25	0.250 to 1.000	107.95	6.35 to 25.40	8.50	0.375 to 1.500	215.90	9.53 to 38.10
4.50	0.250 to 1.000	114.30	6.35 to 25.40	8.75	0.500 to 1.500	222.25	12.70 to 38.10
4.75	0.250 to 1.000	120.65	6.35 to 25.40	9.00	0.500 to 1.500	228.60	12.70 to 38.10
5.00	0.250 to 1.000	127.00	6.35 to 25.40	9.25	0.750 to 1.500	234.95	19.05 to 38.10
5.25	0.250 to 1.000	133.35	6.35 to 25.40	9.50	0.750 to 1.500	241.30	19.05 to 38.10
5.50	0.250 to 1.000	139.70	6.35 to 25.40	9.75	0.875 to 1.500	247.65	22.23 to 38.10
5.75	0.250 to 1.000	146.05	6.35 to 25.40	10.75	0.875 to 1.500	273.10	22.23 to 38.10

Production tolerances

Permissible manufacturing tolerances for outside diameter, wall thickness and cut lengths for hot finished round tubing per ASTM A 511.

			Wall thickness tolerance, %				
Outside diameter inches	Ratio of wall thickness to outside diameter	Outside diameter tolerance inches	0.109" and under	0.109" to 0.172" incl.	Over 0.172" to 0.203" incl.	Over 0.203"	Cut length in. *
Under 3	All wall thicknesses	+/- 0.023	+/- 16.5 %	+/- 15 %	+/- 14 %	+/- 12.5 %	3/16
3 to 5 ½ excl.	All wall thicknesses	+/- 0.031	+/- 16.5 %	+/- 15 %	+/- 14 %	+/- 12.5 %	3/16
5 ½ to 8 excl.	All wall thicknesses	+/- 0.047				+/- 12.5 %	3/16
8 to 10 ¾ excl.	5% and over	+/- 0.047 **				+/- 12.5 %	3/16
10¾	under 5%	+/- 0.063 **				+/- 12.5 %	3/16

* These tolerances apply to cut lengths up to and including 24 ft (7.3 m). For lengths over 24 ft, and additional over tolerance of 1/8" (3.1 mm) for each 10ft (3 m) or fraction thereof shall be permissible, up to a max. tolerance of 1/2" (12.7 mm).

** DMV manufacturing tolerance for these dimensions is +/- 1%.

Materials

Standard grades

Hollow Bar and Mechanical Tubing are supplied in a range of specially selected stainless and acid-resistant standard grades chosen to cover the majority of the corrosion and processing applications in everyday practice.

DMV Designation	USA			Europe EN 10216-5		Others	
	UNS	Designation (grade)	Standard ASTM	Steel No.	Designation	Standard (SS)	Standard (BS)
DMV 304	S 30400	MT 304 (TP 304)	A 511 A (312)	1.4301	X5CrNi18.10	2333	304 S 15
DMV 316	S 31600	MT 316 (TP 316)	A 511 A (312)	1.4401	X5CrNiMo17.12.2		316 S 31
DMV 321	S 32100	MT 321 (TP 321)	A 511 A (312)	1.4541	X6CrNiTi18.10	2337	321 S 31
DMV 316 Ti		TP 316 Ti		1.4571	X6CrNiMoTi17.12.2	2350	
DMV 22.5	S 31803			1.4462	X2CrNiMoN22.5.3		

(...) Grade designation and/or Standard not specific for Hollow Bars.

IMCO® grades

Our improved machinability technology 'IMCO' used advanced technologies and the benefit our integration with COGNE group to deliver consistent improvements in machinability and productivity together with the resilience of integrated supply chain.

IMCO Grades: as an integrated manufacturer we control the non-metallic inclusions to give them characteristics that improve the machinability. We convert the inclusions from hard, abrasive particles to softer self-lubricating particles without comprising important aspects such as corrosion resistance.

IMCO® Designation	DMV Designation	USA		Europe EN 10216-5			Others	
		UNS	Designation (grade)	Standard ASTM	Steel No.	Designation	Standard (SS)	Standard (BS)
IMCO® 304L	DMV 304LMC	S 30403	MT 304L (TP 304L)	A 511 A (312)	1.4307	X2CrNi18.9	2352	304S 11
IMCO® 316L	DMV 316LMC	S 31603	MT 316L (TP 316L)	A 511 A (312)	1.4404	X2CrNiMo17.12.2		316S 11
IMCO® 4435	DMV 316 LMMC				1.4435	X2CrNiMo18.14.3	2353	316S 13

* DMV 316L with 2.5 - 3% Mo.

Machinability Fundamentals

Machining is a critical manufacturing process used across industries to create precise components. As defined by DIN 8580, manufacturing processes are categorized into six main groups, one of which is machining. This process involves material removal in the form of chips and is executed through cutting with either a defined cutting edge (e.g., turning, milling, drilling) or an undefined cutting edge (e.g., grinding, honing). This chapter provides an overview of machining fundamentals, focusing on turning with a defined cutting edge. By understanding these principles, manufacturers can unlock the full potential of materials optimized for machinability, such as hollow bars made from advanced stainless steel.

Machinability refers to a material's suitability for machining under specified conditions. Defined by DIN 6583, it encompasses all material characteristics influencing the machining process. Assessing machinability requires considering:

- Machining Process: (e.g., turning, milling, drilling)
- Cutting Tool Material: (e.g., high-speed steel [HSS], carbide)
- Cutting Conditions: (e.g., speed, feed, cooling)

Key criteria for evaluating machinability include cutting forces, tool wear, and chip formation:

Cutting Forces

Cutting forces are essential indicators of machining efficiency and energy consumption. They are influenced by factors such as cutting speed, feed rate, depth of cut, and tool geometry. High cutting forces can increase tool wear and energy usage, negatively impacting cost-efficiency and surface integrity. Enhanced stainless steel reduces cutting forces, improving machinability and tool life.

Tool wear

Tool wear directly affects surface quality and tool life. Common wear mechanisms include:

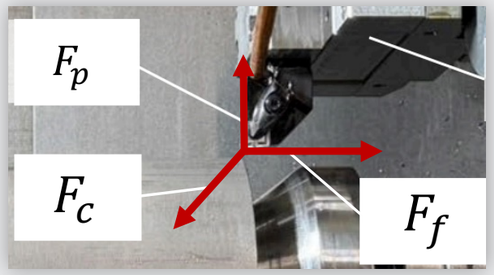
- Abrasive Wear: Caused by hard particles abrading the tool's rake face, resulting in flank and notch wear.
- Adhesive Wear: Occurs when workpiece material adheres to the tool, forming a built-up edge that reduces precision.

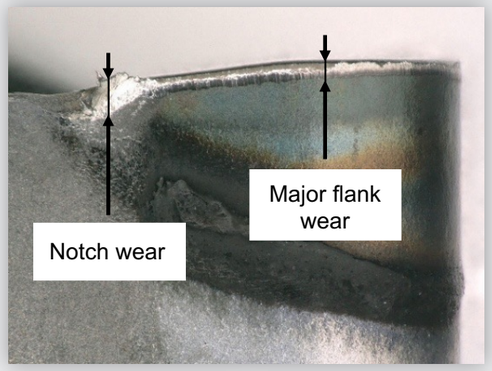
Advanced stainless steel with improved machinability minimizes these effects, ensuring consistent performance and longer tool life.

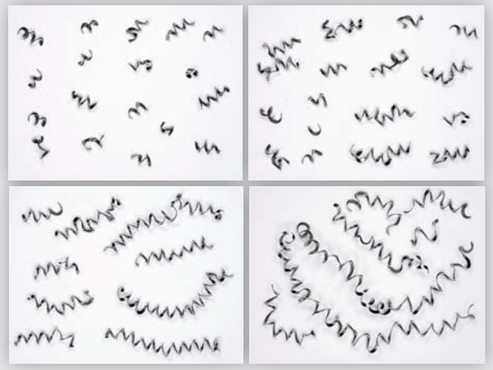
Chip formation:

Chip formation is a key indicator of material machinability. The type of chips formed—such as tear, shear, flow, or lamellar - depends on material properties, cutting tool geometry, and machining conditions.

It is particularly important that chips break into short forms to facilitate easy transport and handling. Long, continuous chips, which can form tangled clusters, may interfere with the machining process, reduce efficiency, and increase the risk of tool damage or workpiece defects. Optimized stainless steel grades help mitigate these issues by promoting controlled chip breakage.







IMCO® – Machinability trails prove enhanced performance

Machinability is a complex property influenced by multiple factors. Key aspects include cutting forces, tool wear progression, and chip formation.

To evaluate the performance of the newly developed IMCO® material, we conducted comparative tests with two other materials that are also marketed for their improved machinability.

The following figures present the results of our tests, providing insight into the performance of IMCO®

For these trials, each material was tested under identical machining conditions for 30 minutes. Every three minutes, an analysis was conducted to assess cutting forces, tool wear, and chip formation.

To ensure comparability, all turning tests were carried out using the exact same parameters—feed rate, cutting speed, and depth of cut—while only the material was varied. This approach isolates the material's influence on machining performance.

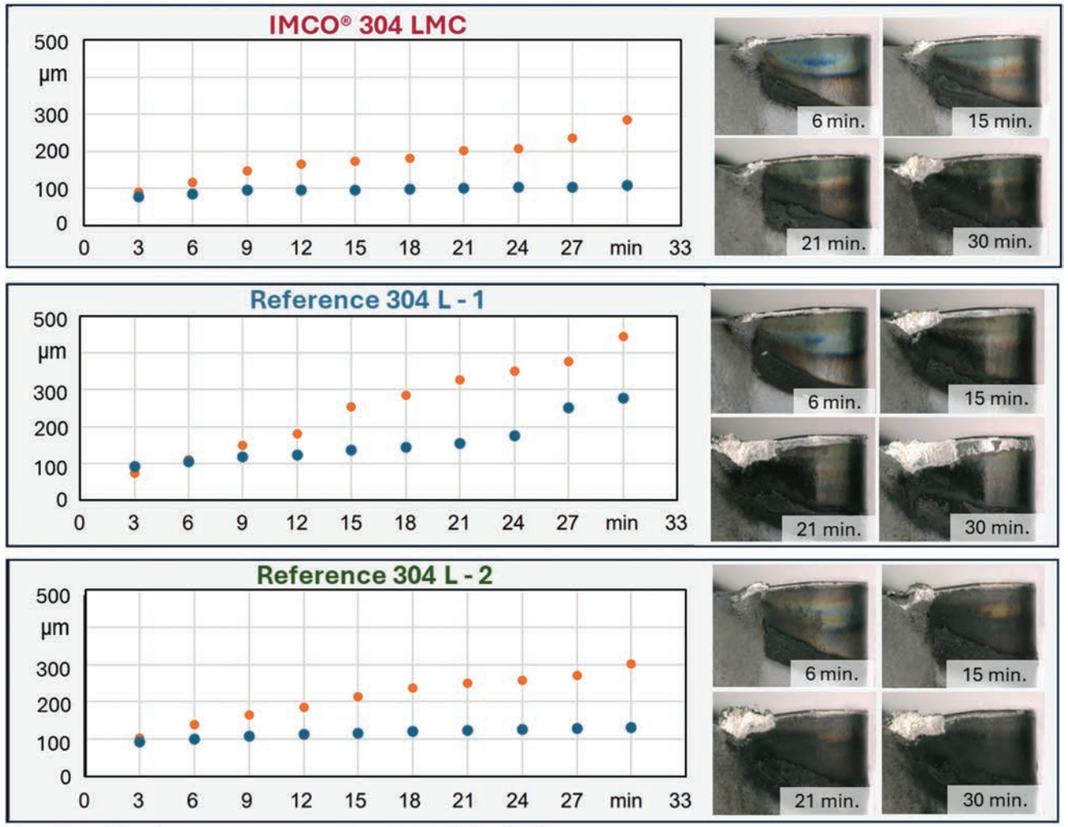
The following figure shows the test setup. Just like the tools used and the resulting cutting edges.

IMCO® – Reduced Tool Wear

The test results clearly demonstrate that IMCO® leads to significantly lower tool wear compared to other materials. Measurements were taken at the main cutting edge, focusing on flank wear and notch wear.

Key Benefits:

- Increased machining productivity
- Reduced production costs and prodution time
- Lower tooling costs
- Shorter chips and improved chip formation

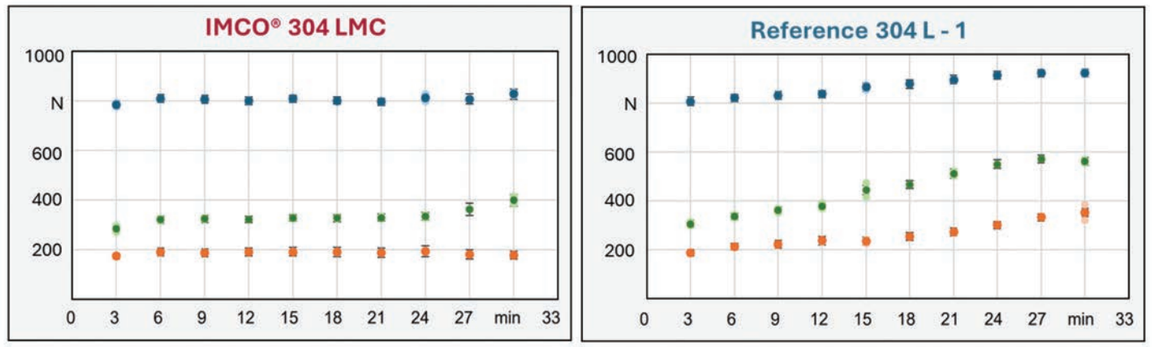


IMCO® – Optimized Machinability with Reduced Cutting Forces

The use of IMCO® results in significantly lower cutting forces compared to reference materials of grade 304L. This reduction applies to cutting force, feed force, and passive force.

Key Benefits:

- Reduced static and dynamic loads on the machine tool
- Improved dimensional accuracy due to minimized machine element deflection
- Lower residual stresses in the workpiece after machining
- Reduced thermomechanical stress

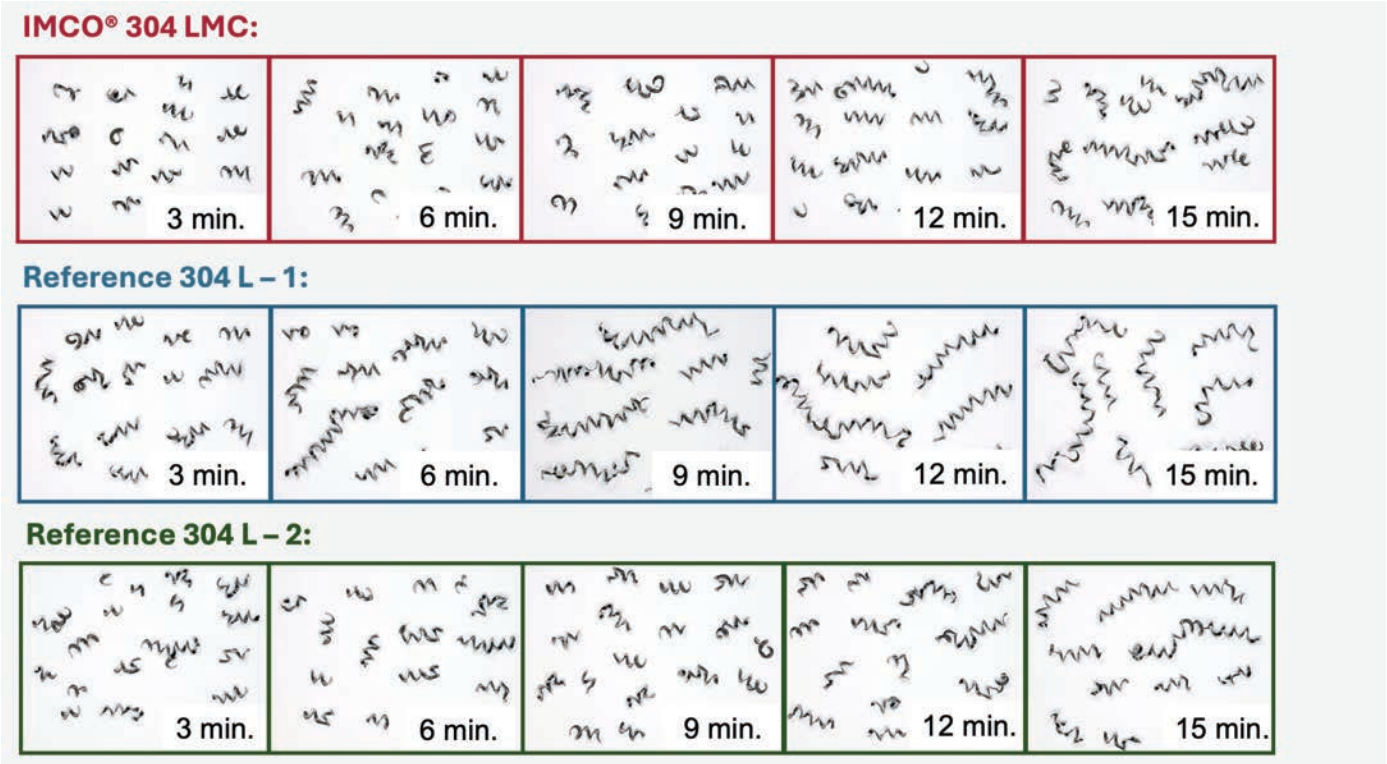


IMCO® – Improved Chip Formation with IMCO®

The test results show that IMCO® exhibits significantly better chip formation compared to reference materials. The chips break more quickly, resulting in shorter chips length.

Key Benefits:

- Improved chip evacuation
- Prevents chip congestion in manufacturing systems, especially in highly automated processes
- Eliminates process interruptions caused by long, tangled chips
- Prevents surface damage from excessive chip lengths



SILVER | Top 15%
ecovadis
Sustainability Rating
FEB 2024

Hollow bar from DMV demonstrates strong sustainability benefits. Improved machinability, reduced tool wear, reduced scrap and the process efficiency that the use of DMV Hollow bar delivers are tangible and deliverable benefits to be considered.

Our Quality Accreditations & Qualifications

QMS / FACILITY	GERMANY, REMSCHEID	ITALY, COSTA VOLPINO	FRANCE, MONTBARD	FRANCE, ISSOUDUN	USA, HOUSTON
ISO 9001	✔	✔	✔	✔	✔
AD 2000	✔	✔	✔	✔	
PED 2014/68/EU	✔	✔	✔	✔	✔
PER 2016/1105		✔	✔		✔
ISO 14001	✔	✔	✔		
ISO 45001			✔		
ISO 17025			✔		
ISO 19443		...	✔		
ASME III		✔	✔		
API - 5CRA	✔	✔	✔		
API - 5LC	✔		✔		
ISO 50001	✔				
AS 9100			✔		

GENUINE QUALITY

DMV QR code system to fight fake products
All of our orders are shipped with QR code validated certificates. Expect authentic DMV quality tubes only with validated QR code.

Material solutions and tube expertise

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