

## MOLYBDENUM ALLOY TZM ABT Arc-Cast Bar

**Description of Product** This specification covers carbon-deoxidized TZM alloy (molybdenum + 0.5 % titanium + 0.08 % zirconium) wrought bar of produced from ingots consolidated by the H.C. Starck consumable electrode vacuum-arc-casting process.

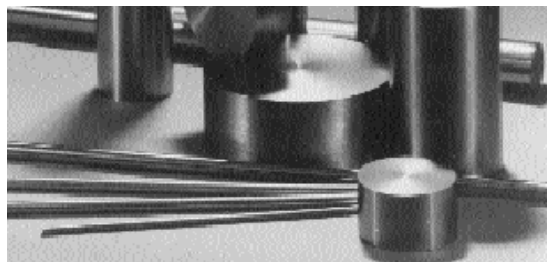
**Chemical Characteristics<sup>1)</sup>**  
(Mass fraction in % [cg/g]; ppm [ $\mu$ g/g])

The chemical composition of the billet used for producing the wrought bar shall conform to the following limits:

Mo(By Difference)	min.	99.25	%
*N	max.	0.002	%
*O	max.	0.003	%
Ni	max.	0.002	%
Fe	max.	0.010	%
Si	max.	0.010	%
C	0.01	-	0.030 %
Zr	0.06	-	0.120 %
Ti	0.40	-	0.550 %

\*Unless method of analysis is agreed upon, deviations from these limits alone shall not be cause for rejection.

**Structure** Bar will be supplied in a stress-relieved condition. Material can be supplied in the recrystallized condition upon request.



**Arc-Cast Products**

1) Information on testing methods on request.

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**Mechanical Properties** The hardness of stress-relieved material will be determined to conform to the following (measured at mid-radius location):

Inches	Diameter	mm	Hardness, DPH (10 kg)	
			Minimum	Maximum
	1/8 to 7/8	3.2 - 22.2	260	320
Over	7/8 to 1 1/8	22.2 - 28.6	250	310
Over	11/8 to 1 7/8	28.6 - 47.6	245	300
Over	17/8 to 2 7/8	47.6 - 73.0	240	290
Over	27/8 to 3 1/2	73.0 - 88.9	235	285

All sizes of recrystallized bar shall exhibit mid-radius hardness of 215 DPH maximum.

Tensile tests are conducted at room temperature (65°F to 85°F) with test specimens made and tested to Specification ASTM E-8) using a strain rate of 0.002 to 0.005 in/in/min through 0.6 % offset and 0.02 to 0.05 in/in/min to fracture.

Tensile properties in the longitudinal direction, using such specimens taken from the center of round bars up to 1 1/4" diameter and from mid-radius location for larger bars, shall meet the following minimum values:

Inches	Diameter	mm	Tensile Strength		Yield Strength (0.2 % Offset)		Elongation % Minimum
			Minimum	Minimum	Minimum	Minimum	
	1/8 to 7/8	3.2 - 22.2	KSI	Mpa	KSI	Mpa	18
Over	7/8 to 11/8	22.2 - 28.6	115	795	100	690	15
Over	11/8 to 17/8	28.6 - 47.6	110	760	95	655	10
Over	17/8 to 27/8	47.6 - 73.0	100	690	85	585	10
Over	27/8 to 31/2	73.0 - 88.9	90	620	80	550	10
			85	585	75	515	5

### Dimensional Tolerances

Inches	Diameter	mm	Diameter Variation				Out-of-Round	
			Inches	mm	Inches	mm	Inches	mm
	1/8 to 9/32	3.2 - 7.1	+0.002	-0.002	+0.05	-0.05	0.004	0.10
Over	9/32 to 13/32	7.1 - 10.3	+0.003	-0.003	+0.07	-0.07	0.006	0.15
Over	13/32 to 5/8	10.3 - 15.9	+0.010	-0.005	+0.25	-0.13	0.012	0.30
Over	5/8 to 7/8	15.9 - 22.2	+0.015	-0.005	+0.38	-0.13	0.015	0.38
Over	7/8 to 1	22.2 - 25.4	+0.020	-0.005	+0.51	-0.13	0.015	0.38
Over	1 to 1 3/8	25.4 - 34.9	+0.020	-0.010	+0.51	-0.25	0.018	0.46
Over	13/8 to 11/2	34.9 - 38.1	+0.020	-0.015	+0.51	-0.38	0.020	0.51
Over	11/2 to 15/8	38.1 - 41.3	+0.025	-0.015	+0.64	-0.38	0.020	0.51
Over	15/8 to 2 1/4	- 50.8+0.030	-0.020	+0.76	-0.51	0.025	0.64	
Over	2 to 2 1/2	50.8 - 63.5	+0.032	-0.032	+0.81	-0.81	0.025	0.64
Over	21/2 to 31/2	63.5 - 88.9	+0.032	-0.032	+0.81	-0.81	0.027	0.69

Special finished bars can be supplied with a tolerance of ± 0.002 inch for 2 inches diameter or smaller sizes, and ± 0.003 inch for larger size bars.

Maximum variation from straightness will be 0.050 inch per foot.

Maximum variation in cut length will be + 1/4 inch, -0.

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<b>Surface Condition and</b>	Bars will be supplied with chemically or mechanically cleaned surfaces.
<b>Internal condition</b>	<p>Minor surface imperfections, revealed by dye penetrant inspection, may be removed by conditioning, provided such removal does not reduce dimensions below specified tolerance limits. Special finished bars will be supplied with a surface finish of 90 RMS or better.</p> <p>The internal integrity of bar &gt;2.0" diameter will be determined by ultrasonic inspection and shall satisfy H.C. Starck Ultrasonic Specification No. H.C. Starck QC-32 (latest version).</p>
<b>Hazards identification in Advertising (Directive 67/548/EEC Article 26, Directive 1999/45/EC Article 13 and REGULATION (EC) No 1272/2008 Article 48)</b>	none.
<b>Identification</b>	Bar will be identified with an appropriate lot number. Each shipping container will be marked with the name of the customer and the purchase order number.
<b>Reports</b>	A product certification report that details pertinent chemical, mechanical, structural and physical integrity features will be provided.
<b>Rejection</b>	H.C. Starck must receive written notification of rejected material with the reason for rejection. The right is reserved to inspect rejected material at customer plant for claim validation. The material may be returned only after proper authorization.

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