



Designation: **F899—20 F899 – 23**

Standard Specification for Wrought Stainless Steels for Surgical Instruments¹

This standard is issued under the fixed designation F899; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification covers the chemistry requirements for wrought stainless steels used for the manufacture of surgical instruments. The data contained in **Tables 1-4** of this specification, including typical hardness values, common heat treating cycles, and examples of selected stainless steels that have been used for surgical instruments, is provided for reference only. Mechanical property requirements, heat treating requirements, hardness requirements, and all other requirements except chemistry are governed by the appropriate material standards as referenced below or as agreed upon between the purchaser and supplier.

1.2 The SI units in this standard are the primary units. The values stated in either primary SI units or secondary inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of each other. Combining values from the two systems may result in ~~non-conformance~~ nonconformance with the standard.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

[ASTM F899-23](https://standards.iteh.ai/catalog/standards/sist/3dd5d131-f0e5-49dc-ac83-b92ca71a806a/astm-f899-23)

<https://standards.iteh.ai/catalog/standards/sist/3dd5d131-f0e5-49dc-ac83-b92ca71a806a/astm-f899-23>

2.1 ASTM Standards:²

~~A276/A276M~~ [Specification for Stainless Steel Bars and Shapes](#)

~~A313/A313M~~ [Specification for Stainless Steel Spring Wire](#)

~~A314~~ [Specification for Stainless Steel Billets and Bars for Forging](#)

~~A480/A480M~~ [Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip](#)

~~A484/A484M~~ [Specification for General Requirements for Stainless Steel Bars, Billets, Shapes, and Forgings](#)

~~A555/A555M~~ [Specification for General Requirements for Stainless Steel Wire and Wire Rods](#)

~~A564/A564M~~ [Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes](#)

~~A582/A582M~~ [Specification for Free-Machining Stainless Steel Bars](#)

~~A751~~ [Test Methods and Practices for Chemical Analysis of Steel Products](#)

2.2 ISO Standards:³

~~ISO 7153-1~~ [Surgical Instruments—Materials—Part Instruments—Materials—Part 1: Metals](#)

~~ISO 9001~~ [Quality Management Systems—Requirements](#)

¹ This specification is under the jurisdiction of ASTM Committee F04 on Medical and Surgical Materials and Devices and is the direct responsibility of Subcommittee F04.12 on Metallurgical Materials.

Current edition approved Feb. 1, 2020 Nov. 1, 2023. Published March 2020 November 2023. Originally approved in 1984. Last previous edition approved in 2019 2020 as F899—19-F899 – 20. DOI: 10.1520/F0899-20.10.1520/F0899-23.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

*A Summary of Changes section appears at the end of this standard

TABLE 1 Typical Maximum Hardness for Selected Class 4 Martensitic Stainless Steels in the Annealed Condition^A

UNS or Type	Typical Maximum Brinell Hardness ^B
410	210
410X	220
416	262
416 Mod	262
420A	220
420B	235
420 Mod	255
420X	262
420C	262
420F	262
420F Mod	262
UNS S42027	255
431	285
440A	285
440A Mod	285
440B	285
440C	285
440F	285
UNS S42026	260
UNS S42010	235
UNS S44027	285

^A Excludes billets and bars for forging.

^B Or equivalent Rockwell hardness.

3. Classification and Type

3.1 *Classes*—Stainless steel material requirements for surgical instruments shall conform to one of the following classes, as specified:

3.1.1 *Class 3*—Austenitic Stainless Steel.

3.1.2 *Class 4*—Martensitic Stainless Steel.

3.1.3 *Class 5*—Precipitation Hardening Stainless Steel.

3.1.4 *Class 6*—Ferritic Stainless Steel.

3.2 *Type*—Where applicable, the commercially recognized type of stainless steel is included in **Tables 5 and 6**.

4. Ordering Information

4.1 Inquiries and orders for material under this specification shall include the following information as agreed upon by the purchaser and supplier:

4.1.1 Quantity (weight or number of pieces),

4.1.2 Classification, optional,

4.1.3 Type,

4.1.4 Form,

4.1.5 Condition (see **5.1**),

4.1.6 Finish (see **5.3**),

4.1.7 Mechanical properties or hardness, and

4.1.8 Applicable dimensions, including size, thickness, width, and length (exact, random, or multiples) or drawing number.

TABLE 2 Typical Heat Treating Cycles and Resultant Hardness Values for Selected Class 4 Martensitic Stainless Steels

Type	Typical Hardening ^A Temperature	Typical Hardness at Indicated Tempering Temperature ^B			Type	Typical Hardening ^A Temperature	Typical Hardness at Indicated Tempering Temperature ^B		
		°C	°F	(HRC)			°C	°F	(HRC)
410	1010 °C [1850 °F] — —	260	-500	43	420G	1038 °C [1900 °F]	149	300	58
		371	-700	43			204	400	55/56
		482	-900 ^C	42			260	500	53/54
		538	1000 ^C	30			315	600	53/54
		593	1100	24			371	700	54/55
410X	1024 °C [1875 °F] — —	260	-500	46	420F	1038 °C [1900 °F]	149	300	52
		371	-700	46/47			204	400	52
		482	900 ^C	48			260	500	50
		538	1000 ^C	44			315	600	50
		593	1100	31			371	700	49
416-Mod	982 °C [1800 °F]	149	-300	38	420F-Mod	1038 °C [1900 °F]	149	300	53
		260	-500	37			204	400	50
		371	-700	37			260	500	48
		482	-900 ^C	35			315	600	48
		538	1000 ^C	30			371	700	48
416	982 °C [1800 °F] —	149	-300	41	UNS S42026	1050 °C [1920 °F]	204	400	56
		260	-500	39			260	500	54/55
		371	-700	41			315	600	53/54
		482	-900 ^C	36			371	700	42
		538	1000 ^C	31			482	900 ^C	45
420A	1010 °C [1850 °F]	149	-300	53	431	1038 °C [1900 °F]	260	500	42
		204	-400	50			371	700	42
		260	-500	48			482	900 ^C	45
		315	-600	48			593	1100 ^C	34
		371	-700	48			149	300	56/57
420B	1038 °C [1900 °F]	149	-300	52	440A	1038 °C [1900 °F]	204	400	56
		204	-400	52			260	500	54
		260	-500	50			315	600	51/52
		315	-600	50			371	700	51
		371	-700	49			427	800 ^D	50
420-Mod	1010 °C [1850 °F]	177	-350	56/57	440A-Mod	1080 °C [1976 °F]	149	300	58
		204	-400	55			204	400	54
		260	-500	54			260	500	53/54
		315	-600	53			315	600	53
		371	-700	49			371	700	53
420X	1038 °C [1900 °F]	315	-600	53	440B	1038 °C [1900 °F]	149	300	58/59
		149	-300	52			204	400	56/57
		204	-400	52			260	500	53/54
		260	-500	50			315	600	53
		315	-600	50			371	700	54
S42010	1038 °C [1900 °F]	371	-700	49	440C	1038 °C [1900 °F]	149	300	60
		427	-800 ^D	49			204	400	59
		204	-400	50			260	500	57
		260	-500	47			315	600	56
		316	-600 ^E	47			371	700	56
S42027	1010 °C [1850 °F]	371	-700	48	440F	1038 °C [1900 °F]	149	300	60
		454	-850	48			204	400	59
		204	-400	50			260	500	57
		260	-500	47			315	600	56
		316	-600 ^E	47			371	700	56
S42027	1010 °C [1850 °F]	371	-700	48	440F	1038 °C [1900 °F]	149	300	60
		454	-850	48			204	400	59
		204	-400	50			260	500	57
		260	-500	47			315	600	56
		316	-600 ^E	47			371	700	56

TABLE 2 Typical Heat Treating Cycles and Resultant Hardness Values for Selected Class 4 Martensitic Stainless Steels

UNS or Type	Typical Hardening ^A Temperature	Typical Hardness at Indicated Tempering Temperature ^B			UNS or Type	Typical Hardening ^A Temperature	Typical Hardness at Indicated Tempering Temperature ^B		
		°C	°F	(HRC)			°C	°F	(HRC)
410	1010 °C [1850 °F] — —	260	500	43	420F	1038 °C [1900 °F]	149	300	52
		371	700	43			204	400	52
		482	900 ^C	42			260	500	50
		538	1000 ^C	30			315	600	50
		593	1100	24			371	700	49
410X	1024 °C [1875 °F]	260	500	46			427	800 ^D	49

UNS or Type	Typical Hardening ^A Temperature	Typical Hardness at Indicated Tempering Temperature ^B			UNS or Type	Typical Hardening ^A Temperature	Typical Hardness at Indicated Tempering Temperature ^B		
		°C	°F	(HRC)			°C	°F	(HRC)
416 Mod	982 °C [1800 °F]	371	700	46/47	420F Mod	1038 °C [1900 °F]	149	300	53
		482	900 ^C	48			204	400	50
		538	1000 ^C	44			260	500	48
		593	1100	31			315	600	48
		149	300	38			371	700	48
416	982 °C [1800 °F]	260	500	37	UNS S42026	1050 °C [1920 °F]	204	400	56
		371	700	37			260	500	54/55
		482	900 ^C	35			315	600	53/54
		538	1000 ^C	30			260	500	42
		593	1100	22			371	700	42
420A	1010 °C [1850 °F]	149	300	41	431	1038 °C [1900 °F]	371	700	42
		260	500	39			482	900 ^C	45
		371	700	41			593	1100 ^C	34
		482	900 ^C	36			149	300	56/57
		538	1000 ^C	31			204	400	56
420A Mod	1038 °C [1900 °F]	260	500	48	440A	1038 °C [1900 °F]	260	500	54
		315	600	48			315	600	51/52
		371	700	48			371	700	51
		427	800 ^D	48			427	800 ^D	50
		149	300	52			149	300	58
420B	1038 °C [1900 °F]	204	400	52	440A Mod	1080 °C [1976 °F]	204	400	54
		260	500	50			260	500	53/54
		315	600	50			315	600	53
		371	700	49			371	700	53
		427	800 ^D	49			427	800 ^D	53
420 Mod	1010 °C [1850 °F]	177	350	56/57	440B	1038 °C [1900 °F]	149	300	58/59
		204	400	55			204	400	56/57
		260	500	54			260	500	53/54
		315	600	53			315	600	53
		371	700	49			371	700	54
420X	1038 °C [1900 °F]	427	800 ^D	49	440C	1038 °C [1900 °F]	149	300	60
		149	300	52			149	300	60
		204	400	52			204	400	59
		260	500	50			260	500	57
		315	600	50			315	600	56
S42010	1038 °C [1900 °F]	371	700	49	440F	1038 °C [1900 °F]	149	300	60
		427	800 ^D	49			204	400	59
		204	400	50			260	500	57
		260	500	47			315	600	56
		316	600 ^E	47			371	700	56
420C	1038 °C [1900 °F]	371	700	48	S42027	1010 °C [1850 °F]	149	300	58/59
		454	850	48			204	400	57/58
		149	300	58			260	500	57/58
		204	400	55/56			315	600	56/57
		260	500	53/54			371	700	56
		315	600	53/54			427	800 ^D	56
		427	800 ^D	55			149	300	58/55 UNS S44027
		204	400	57			204	400	57
		260	500	54			260	500	54
		315	600	53			315	600	53
						371	700	53	
						427	800 ^D	53	

^A The temperatures listed are intended to be guides with the final heat treat cycle determined by the designer or heat treatment engineer, or both, to meet the intended use of the device. Time at temperature depends on section size. It is recommended that a controlled heat treating atmosphere be used in accordance with good commercial practice. Heat treat cycles may use air, oil, or gas for quench.

^B Temper at least 1 h at the indicated temperature and air cool. Large section sizes require longer times at temperature.

^C Tempering in the range of 399/566 °C [750/1050 °F] results in decreased impact strength and reduced corrosion resistance.

^D Tempering over 427 °C [800 °F] results in reduced corrosion resistance.

^E Tempering above 316 °C [600 °F] results in reduced toughness.

TABLE 3 Examples of Selected Stainless Steels That Have Been Used for Surgical Instruments in Accordance with ISO 7153-1

UNS or Type	Cutting Instruments	Non-Cutting Instruments
303	Chisels and gouges, bone curettes	probes
304		retractors
410		tissue, forceps, dressing forceps, retractors, probes
420A		forceps, retractors, probes, forceps with bow handles, branch forceps
420B	Bone rongeurs, conchotomes, bone cutting forceps, chisels and gouges, bone curettes, scissors with carbide inserts	
420C		
420C		
420 Mod	bone rongeurs, conchotomes, bone cutting forceps, chisels and gouges, bone curettes, scissors with carbide inserts, scissors, scalpels, knives	tissue forceps, dressing forceps, retractors, probes, forceps, forceps with bow handles, branch forceps
UNS S44027	chisels, osteotomes, scalpels, and knives	drills, retractors, spreaders, and tongs

TABLE 4 Examples of Selected Stainless Steels That Have Been Used For Surgical Instruments in the United States

UNS or Type	Cutting Instruments	Non-Cutting Instruments
302	knives, chisels, gouges, curettes	cannula, forceps, guides, needle vents, retractors, specula, spreaders, tendon passers, springs
303 ^A	chisels, curettes, knives	cannula, clamps, drills, forceps, handles, hammers, mallets, needle vents, punches, retractors, rulers, screws, skin hooks, specula, spreaders, suction tubes, tendon strips, tongs, tunnelers, probes
304		cannula, clamps, forceps, holders, handles, needle vents, retractors, specula, spreaders, suction tubes, tendon passers
316		specula
410	chisels, curettes, dissectors, osteotomes, reamers, scissors with inserts	clamps, clip applicators, elevators, forceps, hemostats, holders, needle holders, punches, retractors, skin hooks, sounds, spreaders, probes, dilators
410X	curettes, dissectors, rongeurs	clamps, forceps, hemostats, holders, punches, retractors
416 ^A	chisels, curettes, dissectors	clamps, punches, retractors, skin hooks, spreaders
420 ^B	chisels, curettes, cutters, bone cutting forceps, knives, scissors, rongeurs, scalpels, skin punches, conchotomes	clamps, elevators, punches, rounds, dissectors, retractors, skin hooks, needles
420F ^A	cutters	burrs
431		cheek retractors, insertion wrenches, orthopaedic instruments
440 ^C	chisels, knives, osteotomes, scalpels	drills, retractors, spreaders, tongs
440A Mod ^C	chisels, knives, osteotomes, reamers	drills, retractors, raspatory, tongs
420 Mod	chisels, curettes, cutters, bone cutting forceps, knives, scissors, rongeurs, scalpels, skin punches, conchotomes, osteotomes, reamers	clamps, elevators, punches, rounds, dissectors, retractors, skin hooks, needles, cheek retractors, insertion wrenches, orthopaedic instruments, drills, spreaders, tongs, screwdrivers
630	reamers	
XM-16	scissors	drills, needles
XM-13	reamers, rasps	
S11100	reamers, scissors, rasps, knives	Clamps, punches, impactor guides, strike plates, screwdrivers, hex drivers
S11100	reamers, scissors, rasps, knives	clamps, punches, impactor guides, strike plates, screwdrivers, hex drivers
S46500	reamers, scissors, rasps, knives	Clamps, punches, impactor guides, strike plates, screwdrivers, hex drivers
S46500	reamers, scissors, rasps, knives	clamps, punches, impactor guides, strike plates, screwdrivers, hex drivers
UNS S44027	knives and scalpels	drills

^A It is not recommended that free-machining grades be used for critical portions of surgical instruments. Free-machining grades should only be considered for instrument applications when appropriate steps can be taken during manufacture to minimize the inherent limitations of this class of alloys (see 10.1).

^B Types 420A, 420B, 420C, or UNS S42026 may be used depending on instrument design and application.

^C Types 440A, 440A Mod, 440B, or 440C may be used depending on instrument design and application.

5. Manufacture

5.1 *Condition*—Stainless steels shall be furnished to the purchaser, as specified, in the hot-finished, cold-finished, annealed, solution-treated, solution-treated and aged, quench-hardened and tempered, or as specified by the purchaser. (Note that highly hardenable martensitic stainless billets and bars such as Types 420A, 420B, 420C, 420 Mod, 420F, 420F Mod, 440A, 440A Mod, 440B, and 440C intended for forging are commonly annealed prior to shipment and so specified in order to avoid the possibility of thermal cracking. Other hardenable martensitic grades such as Types 403, 410, 416, 416 Mod, and 431, which also may require annealing, depending on their composition and size, are furnished suitable for cold cutting when so specified on the purchase order.) Type 302PH (S17710) may be furnished as hot-rolled or hot-formed, cold drawn or cold drawn, and age-hardened.

5.2 *Conditioning*—Billet and bar intended for forging may be conditioned by chipping, grinding, or other suitable means to remove injurious surface defects.

TABLE 5 Composition of Class 3, Austenitic Stainless Steels, %

UNS	Type	Carbon, max ^A	Manganese	Phosphorus, max	Sulfur	Silicon, max ^A	Chromium	Nickel	Other Elements
S30100	301	0.15	2.00 max	0.045	0.030 max	1.00	16.00–18.00	6.00–8.00	—
S30100	301	0.15	2.00 max	0.045	0.030 max	1.00	16.00–18.00	6.00–8.00	...
S30151		0.07–0.09	1.50–2.00	0.025	0.010 max	1.20–1.80	16.0–18.0	7.0–9.0	Cu 0.40 max Mo 0.50–1.00 N 0.07–0.11
S30200	302	0.15	2.00 max	0.045	0.030 max	1.00	17.00–19.00	8.00–10.00	N 0.10 max ^B
S30300	303	0.12 ^B	2.00 max	0.06 ^B	0.15–0.35 ^B	1.00	17.00–19.00	8.00–10.00	Mo 0.70 max ^B
S30400	304	0.07 ^B	2.00 max	0.045	0.030 max	1.00	17.00–19.00 ^B	8.00–11.00 ^B	N 0.10 max ^B
S31600	316	0.07 ^B	2.00 max	0.045	0.030 max	1.00	16.50–18.50 ^B	10.50–13.50 ^B	Mo 2.00–2.50 ^B N 0.10 max ^B
S31700	317	0.08	2.00 max	0.045	0.030 max	1.00	18.00–20.00	11.00–15.00	Mo 3.00–4.00 N 0.10 max ^B
S30430	XM-7	0.1	2.00 max	0.045	0.030 max	1.00	17.00–19.00	8.00–10.00	Cu 3.00–4.00
S28200		0.15	17.00–19.00	0.040	0.04 max	1.00	17.00–19.00	—	Mo 0.75–1.25
S28200		0.15	17.00–19.00	0.040	0.04 max	1.00	17.00–19.00	...	Mo 0.75–1.25 Cu 0.75–1.25 N 0.40–0.60
S20161		0.15	4.0–6.0	0.045	0.030	3.0–4.0	15.00–18.00	4.0–6.0	N 0.08–0.20
S20162		0.15	4.0–8.0	0.040	0.040	2.5–4.5	16.50–21.00	6.0–10.0	N 0.05–0.25
S21800		0.10	7.0–9.0	0.060	0.030	3.5–4.5	16.0–18.0	8.0–9.0	N 0.08–0.18
S30117	1.4310	0.050–0.150	2.00 max	0.045	0.015 max	2.00	16.00–19.00	6.00–9.50	Mo 0.80 max, N 0.110 max

^A Max if not expressed as a range.

^B Denotes more restrictive limit than UNS.

TABLE 6 Composition of Class 6, Ferritic Stainless Steels, %

UNS	Type	Carbon, max	Manganese, max	Phosphorus, max	Sulfur	Silicon, Max	Chromium	Other Elements
S43020	430 F	0.08 ^A	1.25	0.06	0.15–0.35 ^A	1.00	16.00–18.00	Mo 0.60 max Ni 1.00 max ^A
S18200	XM-34	0.08	1.25–2.5 ^A	0.04	0.28–0.41 ^A	1.00	17.50–19.50	Mo 1.50–2.50
S18235		0.025	0.50	0.040	0.15–0.35	1.00	17.5–18.5	Mo 2.00–2.50 Ni 1.00 max N 0.025 max Ti 0.030–1.00 C+N 0.035 max

^A Denotes more restrictive limit than UNS.

ASTM F899-23

<https://standards.iteh.ai/catalog/standards/sist/3dd5d131-f0e5-49dc-ac83-b92ca71a806a/astm-f899-23>

5.3 *Finish*—Types of finish available for bar and wire products are cold-drawn, pickled, ground, ground and polished, or as specified in the purchase order.

6. General Requirements for Delivery

6.1 In addition to the chemistry requirements of this specification, all requirements of the current editions of Specifications [A276/A276M](#), [A313/A313M](#), [A314](#), [A480/A480M](#), [A484/A484M](#), [A555/A555M](#), [A564/A564M](#), [A582/A582M](#), and Test Methods, Practices, and Terminology [Methods and Practices A751](#) shall apply where applicable, as agreed upon between the purchaser and supplier.

6.2 This specification complements the applicable ISO document covering stainless steel for surgical instruments and, by reference, includes all of the stainless grades in ISO 7153-1.

7. Chemical Requirements

7.1 The heat analysis shall conform to the requirements as to chemical composition specified in [Tables 5-8](#).

7.2 Unified Numbering System (UNS) designations have been added to [Tables 5-8](#) to provide an easy cross reference to a common numbering system. In order to ensure consistency in the materials used for the manufacture of surgical instruments, compositional limits tighter than typical UNS limits have been established for certain elements (as denoted by an asterisk). For example, more restrictive carbon and sulfur limits are specified in [Table 7](#).