Stainless steel and magnetism

Swiss Steel Group

Ugitech offers a range of grades completely dedicated to magnetic applications

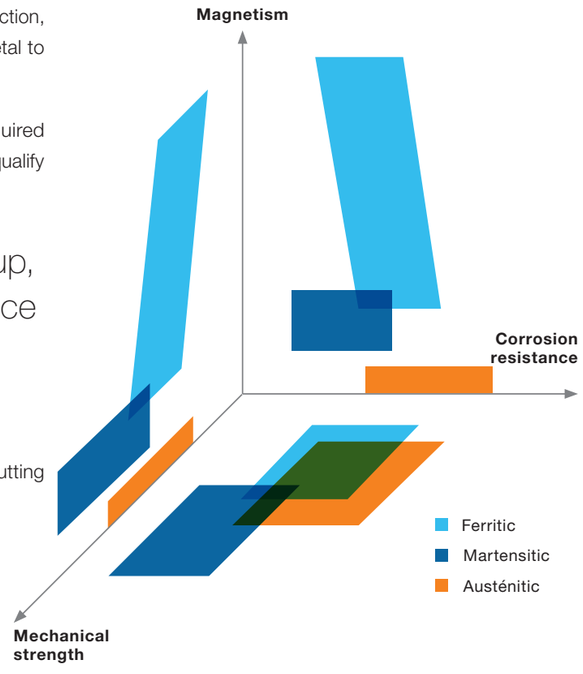
Ugitech has recognized expertise thanks to more than twenty-five years' experience in the production of products for soft magnetic cores.

Ugitech provides its customers with fully integrated production, allowing complete control of quality, from the liquid metal to the inspected magnetic bar.

To meet the market requirements, Ugitech has acquired standardized means of measurement: permeameter to qualify materials' static and dynamic magnetic behaviour.

Ugitech, in the Swiss Steel Group, has a global commercial presence thanks to its international sales network.

Thanks to its research and development centre on the cutting edge of innovation and its technical support, Ugitech is able to assist you with the choice of materials, to improve performance and develop your solutions.



Properties	Grades	Functions	Applications	Markets
Ferromagnetic	Ferritic	Magnetic cores, solenoids	Solenoid valves Electric pumps Injectors Electromagnets Switch-disconnectors	Automotive, food, electricity, industrial processes (chemicals, petrochemicals)
	Martensitic	Magnetic coupling parts		
Non-magnetic	Austenitic	Insensitive to magnetic fields		Building Metrology

A broad range of grades to meet your needs

Family	Ugitech grade	EN	ASTM / AISI	Other	C	Si	Mn	Ni	Cr	Mo	S	N	Nb	Al
8%Cr	UGI® 4713 / UGIPERM® 8	1.4713			≤ 0.12	0.5 - 1.0	≤ 1.0	≤ 0.5	6.0 - 8.0		≤ 0.015			0.5 - 1.0
12%Cr	UGI® 4003	1.4003			≤ 0.030	≤1.0	≤ 1.5	0.3 - 1.0	10.5 - 12.5	≤ 0.6	≤ 0.030	≤ 0.03		
	UGI® 4045 / UGIPERM® 11FM	1.4045			≤ 0.030	≤1.0	≤ 1.5	≤ 0.5	11.0 - 13.0	≤ 0.6	0.15 - 0.35	≤ 0.03		
	UGIPERM® 12FM	1.4045			≤ 0.020	1.0 - 2.0	≤ 0.5	≤ 0.5	11.5 - 13.0	0.2 - 0.7	0.15 - 0.25	≤ 0.07		
17%Cr	UGI® 4511*	1.4511	430		≤ 0.050	≤1.0	≤1.0	≤ 0.5	16.0 - 18	≤ 0.6	≤ 0.030	≤ 0.02	12xC - 1.0	
	UGI® 4016LS	1.4016	430		≤ 0.030	≤ 0.75	≤1.0	≤ 0.5	16.0 - 18	≤ 0.6	≤ 0.030	≤ 0.07		
	UGI® 4105*	1.4105	430F		≤ 0.08	≤ 0.6	≤1.5	≤ 0.5	16 - 18	0.2 - 0.6	0.15 - 0.35	≤ 0.07		
	UGI® 4105Si / UGI® 430FR	1.4105	430FR	ASTM A838 Alloy 2	≤ 0.08	1.0 - 1.5	≤ 0.8	≤ 0.5	17.25 - 18	0.2 - 0.6	0.15 - 0.35	≤ 0.07		
	UGI® 4105B	1.4105	430F		≤ 0.05	≤ 0.6	≤ 1.5	≤ 0.5	16 - 18	0.2 - 0.6	0.15 - 0.30	≤ 0.07		
	UGI® 430FX4	1.4105	430F	ASTM A838 Alloy 1	≤ 0.065	0.3 - 0.7	≤0.8	≤ 0.5	17.25 - 18.25	≤ 0.5	0.25 - 0.40			
	UGIPERM® 17FM				≤ 0.020	≤ 0.6	≤ 1.5	≤ 0.5	18 - 19	0.2 - 0.6	0.15 - 0.30	≤ 0.07	0.20 - 0.35	
17%Cr + Mo	UGI® 4113	1.4113	434		≤ 0.08	≤1.0	≤1	≤ 0.5	16 - 18	0.9 - 1.4	≤ 0.030	≤ 0.07		
	UGI® 4114	1.4114	434F		0.05 - 0.08	≤1.0	≤1.5	≤ 0.75	17.5 - 19	1.5 - 2.5	0.15 - 0.25	≤ 0.07		
	UGI® 4106 / IMRE®	1.4106		IMRE®	≤ 0.030	1.2 - 1.6	≤0.6	≤ 0.5	17.5 - 18	1.5 - 2	0.20 - 0.35	≤ 0.07		
	UGIPERM® 18FM				≤ 0.030	0.6 - 1.0	≤0.6	≤ 0.5	17.5 - 18	1.5 - 2	0.20 - 0.35	≤ 0.07	0.15 - 0.35	

* Grades also available in UGIMA® version (enhanced machinability)

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Ferritic steels

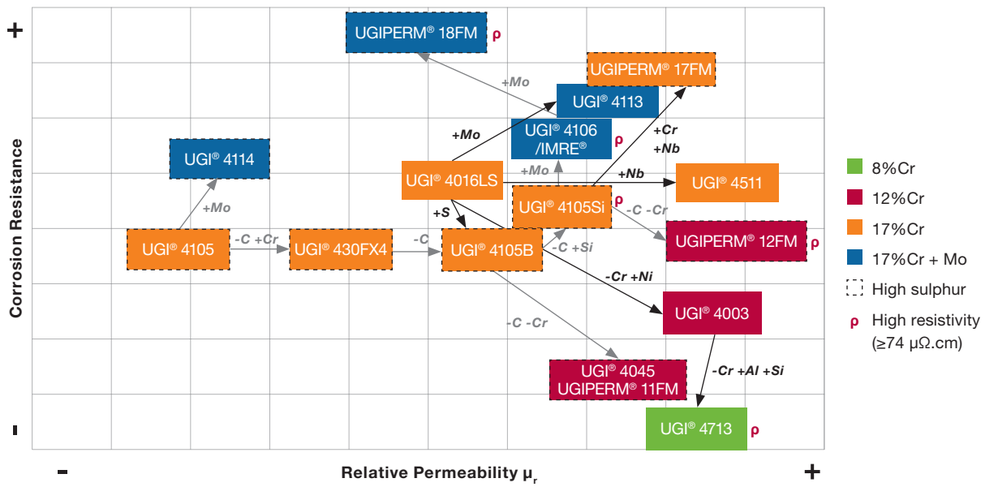
Ugitech offers a comprehensive range of ferritic stainless steels with soft magnetic properties, specifically for electromagnetic actuators.

The choice of the most suitable grade for a given application is a trade-off between magnetic properties, electrical resistivity, corrosion resistance, machinability and weldability.

Comparison of the main soft ferritic grades (magnetic properties shown in the magnetically annealed condition). Typical values, non contractually binding.

Family	Grades	µr max	Hc (A/m)	Br (T)	Js (T)	r (µΩ.cm)	Corrosion	Machinability
8%Cr	UGI® 4713	2000	130	0.7	1.82	74	•	••
12%Cr	UGI® 4003	2000	130	0.8	1.72	64	•	••
	UGI® 4045 / UGIPERM® 11FM	1700	150	0.7	1.71	69	•	••••
	UGIPERM® 12FM	2000	130	0.8	1.69	79	••	••••
17%Cr	UGI® 4511	2000	130	0.8	1.64	58	•••	••
	UGI® 4016LS	1500	160	0.7	1.65	58	•••	••
	UGI® 4105	700	400	0.6	1.61	62	••	••••
	UGI® 4105Si / UGI® 430FR	1600	150	0.6	1.54	78	•••	••••
	UGI® 4105B	1400	240	0.8	1.6	62	••	••••
	UGI® 430FX4	1050	350	0.8	1.57	61	••	••••
	UGIPERM® 17FM	1800	180	0.9	1.58	60	••••	••••
17%Cr + Mo	UGI® 4113	1700	180	0.9	1.62	60	••••	••
	UGI® 4114	800	600	0.8	1.56	60	••••	••••
	UGI® 4106 / IMRE®	1600	150	0.7	1.5	76	••••	••••
	UGIPERM® 18FM	1300	250	0.8	1.55	76	•••••	••••

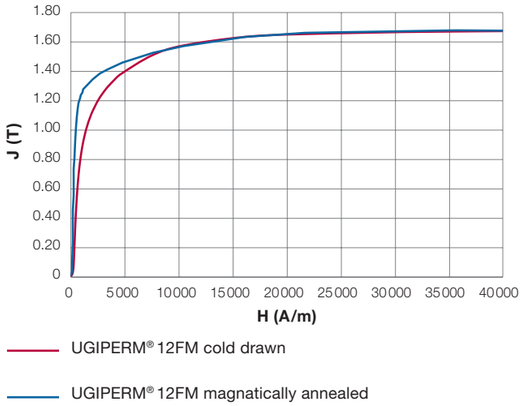
Positioning of the Ugitech ferritic steel offer according to pitting corrosion resistance and relative permeability.

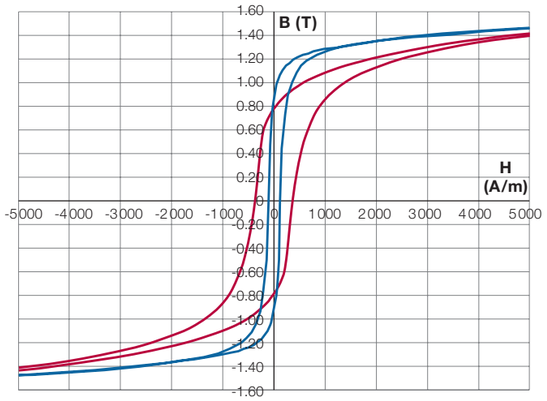


Performing a magnetic annealing operation on ferritic stainless steel bars will significantly improve the magnetic performance of the material (higher µr and lower Hc). In parallel, the mechanical properties (UTS, YS, hardness) will decrease : the material is softer.

Comparison of magnetic curves for the same material in drawn and magnetically annealed condition:

Grades	Ø (mm)	Condition	Hc (A/m)	µr max	Br (T)	Jmax (T)	Rm (MPa)	Hardness HB
UGIPERM® 12FM	12	cold-drawn	370	825	0.80	1.68	659	264
UGIPERM® 12FM	12	cold + magnetically annealed + ground	110	2845	0.90	1.68	485	165





Martensitic steels

These grades are magnetically harder than ferritic steels (Hc > 1000 A/m). They are recommended when you want a trade-off between ferromagnetic properties and high mechanical strength. Their scope of application is very broad, from actuators to sensors.

Magnetic properties depend greatly on the heat treatments performed (quenching and tempering) and are therefore not independent of the mechanical properties. Depending on the trade-off wanted (between mechanical and magnetic properties), please consult us.

Ranges of variation in the magnetic properties of certain martensitic grades

Grades	μ_r max	Hc (A/m)	Js (T)	ρ (µΩ.cm)	Corrosion	Machinability
UGI® 4034	≤ 600	1000 - 7000	1.30 - 1.75	55	•	•
UGI® 4313	≤ 300	1000 - 3000	1.30 - 1.65	60	•••	•
UGI® 4418	≤ 300	1000 - 3000	1.10 - 1.50	80	••••	•
UGI® 4542	≤ 400	500 - 4000	1.00 -1.50	72	•••••	•

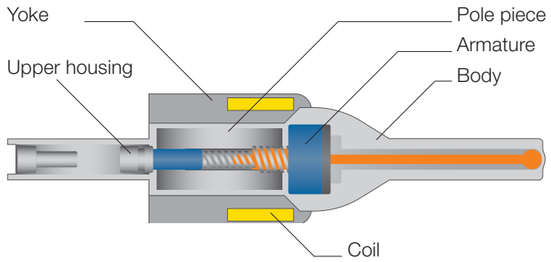
Size ranges and services

		Round bars	Hexagonal bars	Shaped bars
Size range	**Without magnetic annealing**	2 – 76 mm	3 – 55 mm	As per drawing
	Magnetic annealing **	4.5 – 28 mm *	4.5 – 28 mm	As per drawing
Finishes		Turned and polished Drawn Ground	Drawn	Drawn
Lengths		1.5 – 4.0 m	1.5 – 4.0 m	As per drawing
Tolerances		As per ISO or EN standards or as per customer specification		
Ultrasonic inspection		10 – 28 mm	-	-
Eddy current testing		3 – 76 mm	3 – 55 mm	-

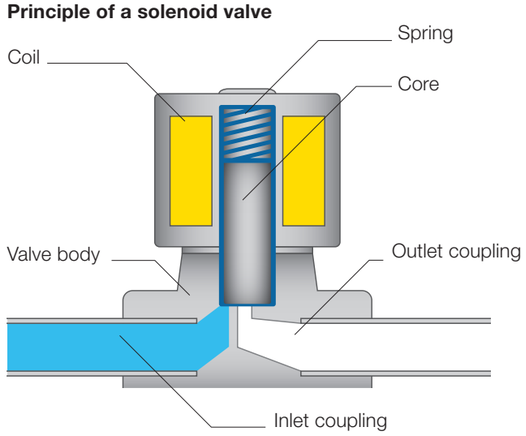
– Metallurgical condition with or without magnetic annealing.

– Finishes: drawn, turned and polished or ground

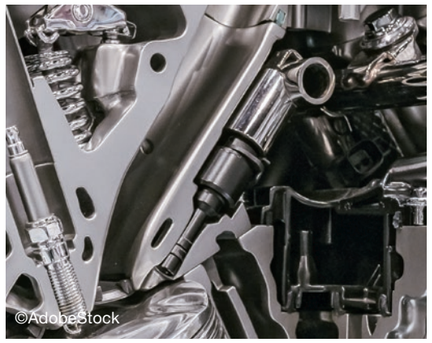
Principle of an electromagnet fuel injector



Principle of a solenoid valve



*Other cases: please consult us
**Annealing applies only to ferritic grades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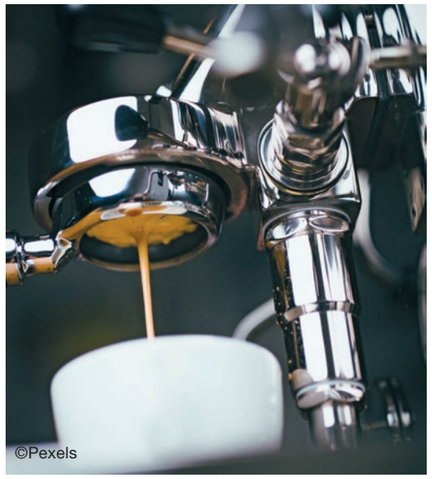
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Quality management specifically for the magnetism market

Regarding quality control and product conformity, Ugitech has

ISO 17025

certification in an area ranging from chemical analysis to mechanical testing, and including metallographic inspections and non-destructive inspections.

To qualify the materials, Ugitech has the whole range of magnetic measurement techniques, all standardized:

– Type A direct-current permeameter: measurement on bars as per EN 60404-4 and ASTM A341/A341M

– Permeability measurement on feebly magnetic materials

For ferromagnetic grades, a permeameter can be used to determine the B(H) curves of first magnetization and the hysteresis cycle, from which the values μr max, Hc, Br and Js are deduced.

To allow for the requirements of markets using magnetic products, Ugitech has integrated several certifications: ISO 9001 and ISO TS 16496.

Ugitech is equipped with the latest non-destructive inspection technologies (eddy current, ultrasonic) for inspecting magnetic grades.

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