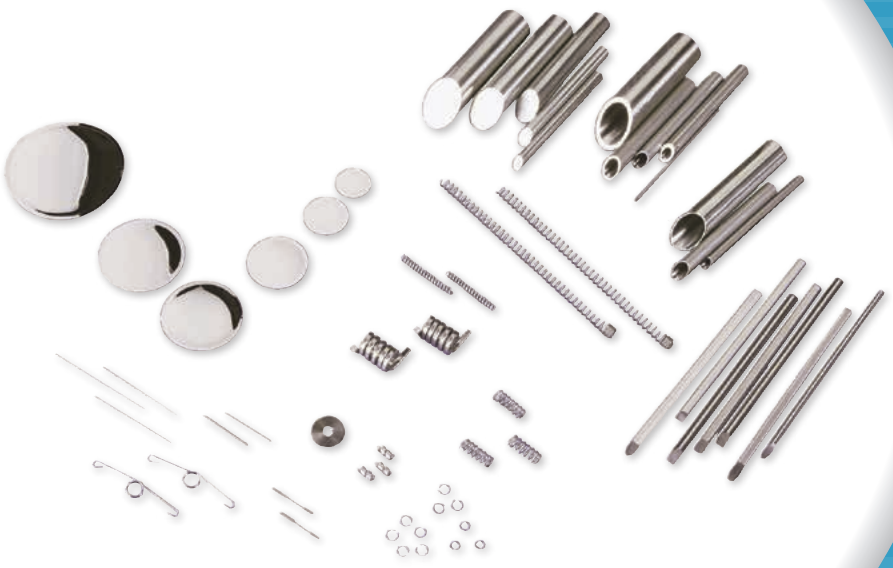
SII

SEIKO GROUP

Superior performance Co-Ni Alloy Product (SPRON)®



Seiko Instruments Inc.

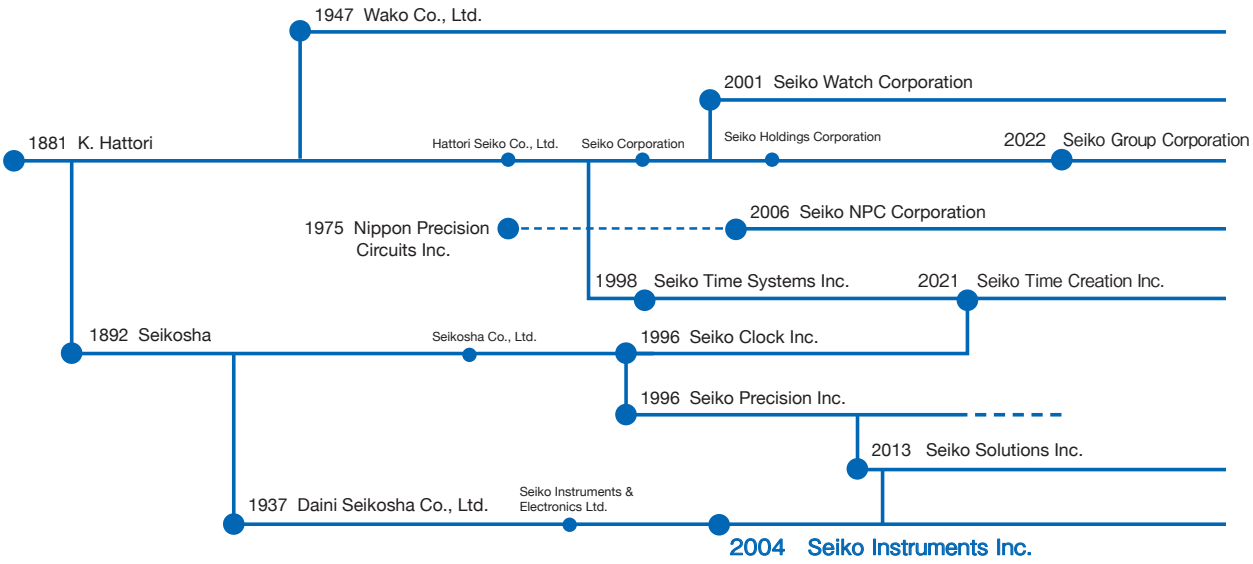
Creating Time - Optimizing Time - Enriching Time

Seiko Instruments Inc. (SII), founded in 1937 as a member of the Seiko Group specializing in the manufacture of watches, has leveraged its core competency in high precision watches to create a wide range of new products and technologies.

Over the years SII has developed high-precision processed parts and machine tools that pride themselves on their sub-micron processing capability, quartz crystals that came about as a result of our quartz watch R&D, and electronic components such as micro batteries. Optimizing our extensive experience and expertise, we have since diversified into such new fields as compact, lightweight, exceedingly quiet thermal printers, and inkjet printheads, a key component in wide format inkjet printers for corporate use.

SII, in the years to come, will maintain an uncompromised dedication to its time-honored technologies and innovations of craftsmanship, miniaturization, and efficiency that meet the needs of our changing society and enrich the lives of those around us.

Genealogy of Seiko Group



CONTENTS

It all started with the precision spring. With its evolution came the Co-Ni alloy product that is paving the way of the future.

Power spring in mechanical watches

The Grand Seiko is equipped with the SPRON

■ History of SPRON

The Sendai Precision Materials Laboratory – the predecessor of the Sendai Unit where production of SPRON is based – began collaborating in 1953 with the Institute of Materials Research, Tohoku University to develop the spring that serves as a power source for mechanical watches. In 1956, we succeeded in developing SPRON 100, a strain age-hardening type, high-elastic and high-corrosion-resistant alloy that leverages the work-hardening properties of the cobalt base.

In 1957, Sendai Precision Materials Laboratory began producing watch springs as a watch spring manufacturing company. Combining the material's properties with the precision processing technology allowed SPRON to be used in a wide range of high-precision springs and as spring material in medical instruments.

Later, growing needs for enhancements in super-miniaturization technology and high-performance spring material led to the development of SPRON 510, featuring material strength and corrosion resistance surpassing that of SPRON 100.

Originating as a part with a dimension of only a few millimeters, the SPRON 510 is now used for precision spring material in fields related to semiconductors, dental, medical, and others.

The SPRON also serves as a part of the power spring in the Grand Seiko and other mechanical watches under the Seiko brand.

■ The origin of the name "SPRON"

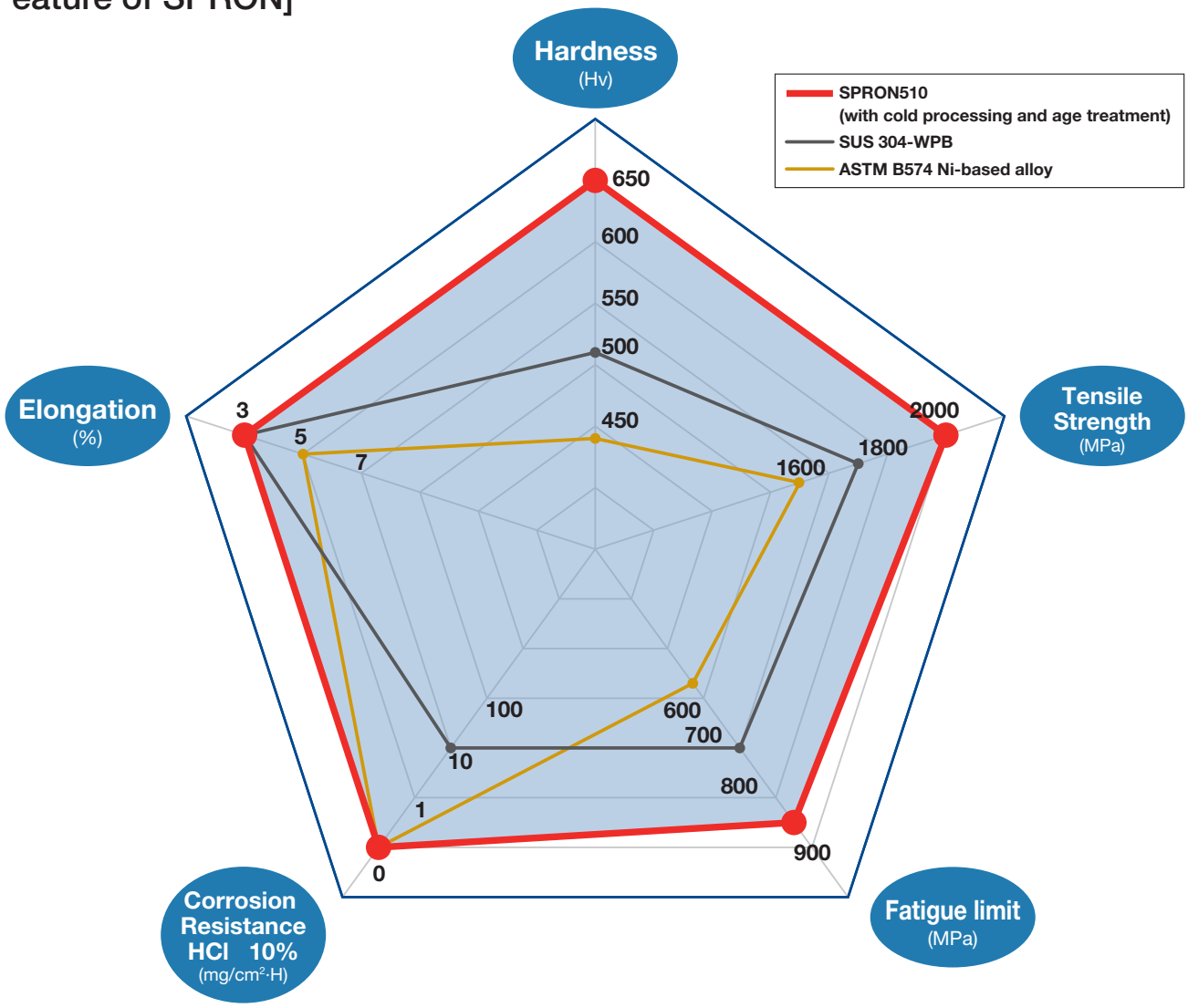
The name SPRON is coined from "SPRING + MICRON." As the name implies, our precision springs boast outstanding material properties and are machined to a precision finish controlled to the micron level.

* SPRON is a registered trademark of Seiko Instruments Inc.

■ SPRON510

In 1956, the superior performance Co-Ni alloy product (SPRON) was developed as spring material in “Grand Seiko”, the high grade mechanical watch, through collaboration with the Institute of Materials Research, Tohoku University.
SPRON510 is corrosion resistant and significantly excellent at every aspect of mechanical characteristics below.

[Feature of SPRON]

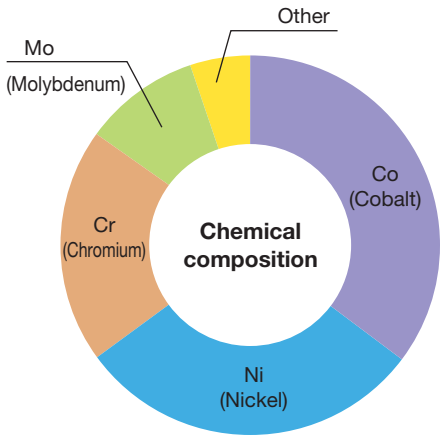


[Mechanical and physical characteristics]

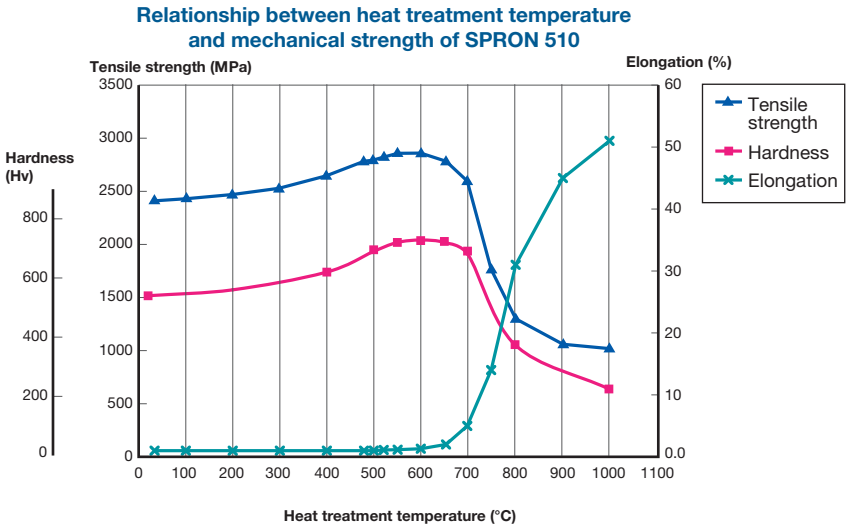
Tensile strength	Stiffness	Elongation	Hardness	Density	Young's modulus	Modulus of rigidity	Linear expansion coefficient (20 to 50°C)	Electrical resistivity	Intensity of magnetization (5k0e)	Poisson's ratio
Up to 2940MPa (Up to 300kg/mm^2)	Up to 5684MPa (Up to 580kg/mm^2)	3%	Hv. to 800	8.5 to 8.7 g/cm^3	216 to 225GPa (22 to 23×10^{3}kg/mm^2)	83.3GPa (8.5×10^{3}kg/mm^2)	12 to 13×10^{-6}/°C	98 to 100μΩ-cm	0	0.33

<Measured a wire drawing material with cold processing and age treatment>

■ Chemical components



■ Relationship between mechanical characteristics and heat treatment temperature



* The above graph shows the tensile strength, hardness, and elongation when a material with 90% processing rate of wire-drawing is heat-processed at each temperature for two hours.

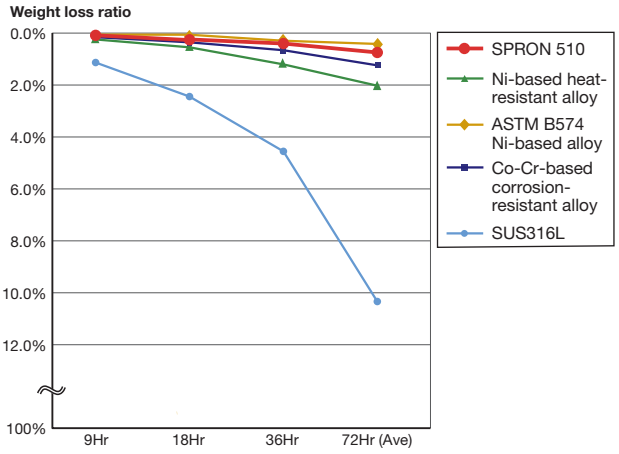
■ Five advantages of SPRON

1. No Corrosion

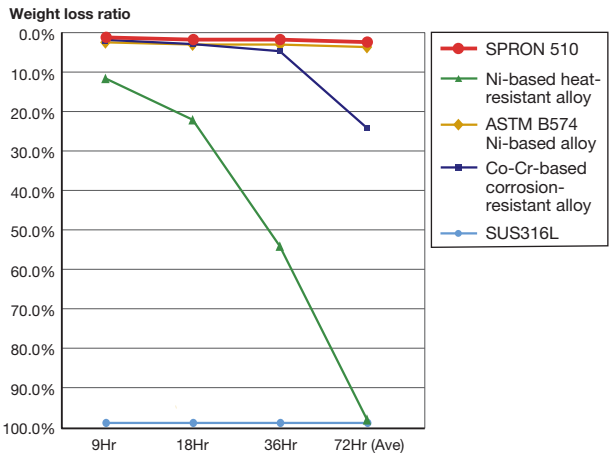
Results of corrosion tests in 48% hydrogen bromide (HBr) and 36% hydrochloric acid (HCl) show that SPRON 510's corrosion resistance is superior to that of the corrosion-resistant metal materials shown below.

Corrosion resistance of SPRON510 and other Metals

Immersion: 48%HBr (Hydrogen bromide)



Immersion: 36%HCl (hydrochloric acid)

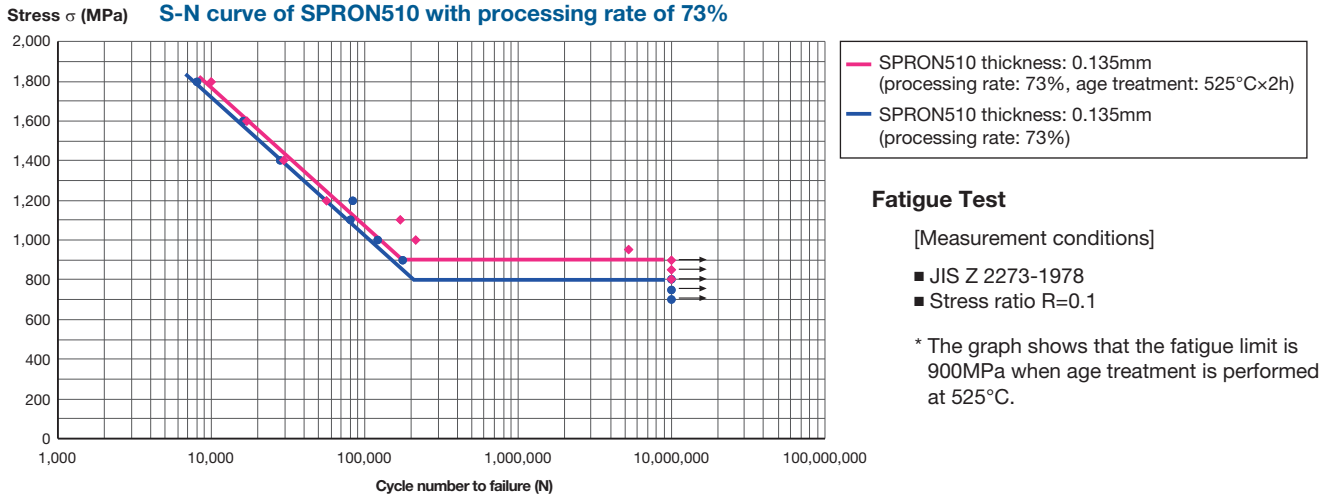


[Measurement conditions] ■ Test piece: ϕ20mm, Mass 0.2 to 0.3g
■ Immersion: 48%HBr (60°C) / 36%HCl (60°C)

2. Strong

The fatigue limit of SPRON510 (processing rate when rolled: 73%, age treatment: 525°C) is 900MPa.

S-N Curve



Fatigue Test

[Measurement conditions]

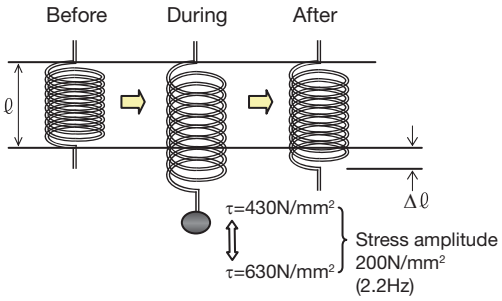
- JIS Z 2273-1978
- Stress ratio R=0.1

* The graph shows that the fatigue limit is 900MPa when age treatment is performed at 525°C.

3. Elastic

Fatigue due to both statistical and dynamic loads is very small, achieving large spring load by a fine spring. Relaxation rate after 1,000,000 times of tensile spring tests of SPRON510 is one-fifth or one-sixth as much as that of piano wire.

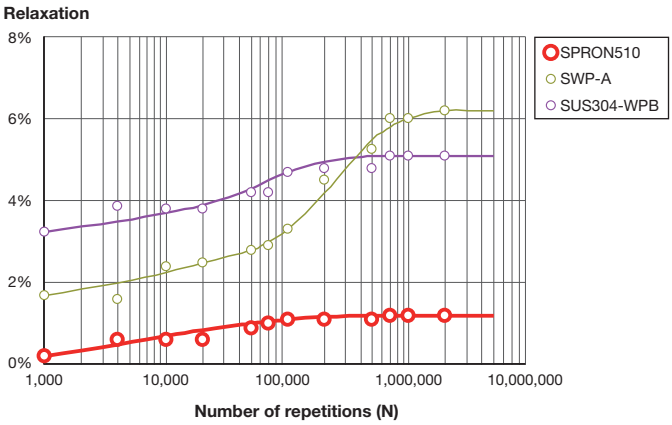
Relaxation and Number of repetition due to tensile spring test



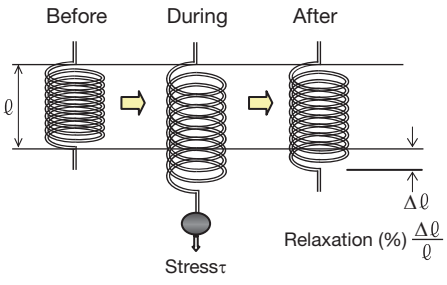
Repeated Stress×N (τ×N)

[Measurement conditions]

- Wire diameter: ϕ0.3mm
- Center diameter: ϕ3mm
- Number of coils: 33-35
- Free length: 16.0mm

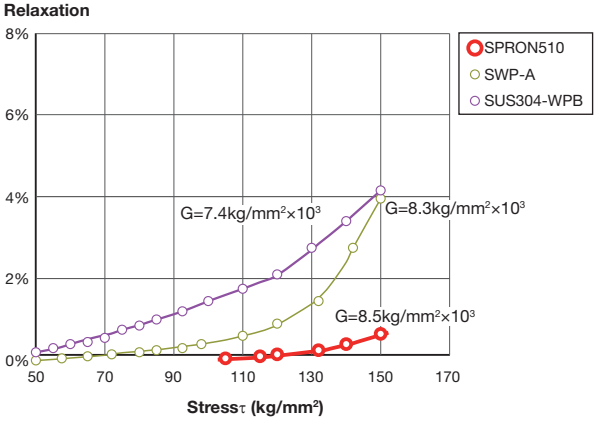


Relaxation and Stress due to tensile spring test



[Measurement conditions]

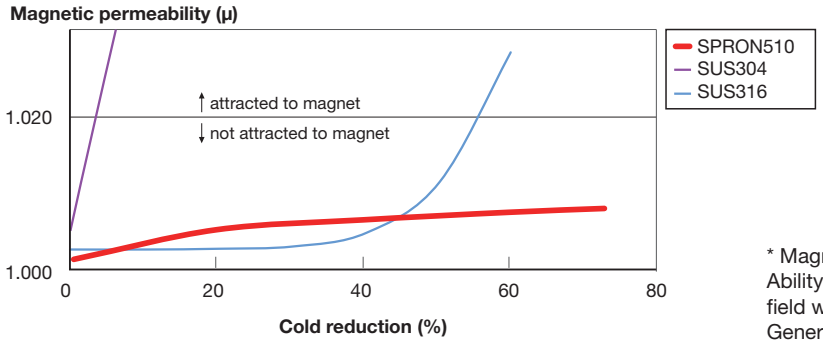
- Wire diameter: ϕ0.3mm
- Center diameter: ϕ3mm
- Number of coils: 35
- Free length: 16.5mm



4. No Magnetization

SPRON is suitable for parts in measurement/analysis equipment that will not welcome magnetism.

Magnetic characteristic (permeability)



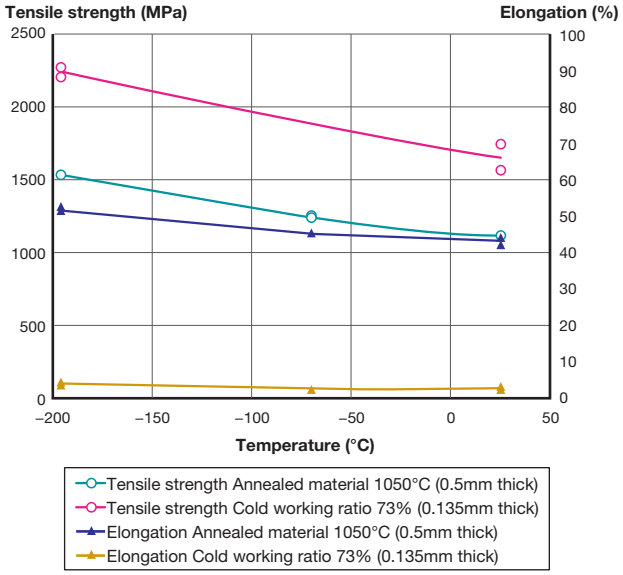
* Magnetic permeability (μ)
Ability of a material to support the formation of a magnetic field within itself.
Generally, a material with μ<1.02 is regarded as non-magnetic.

5. Heat resistant (both hot and cold)

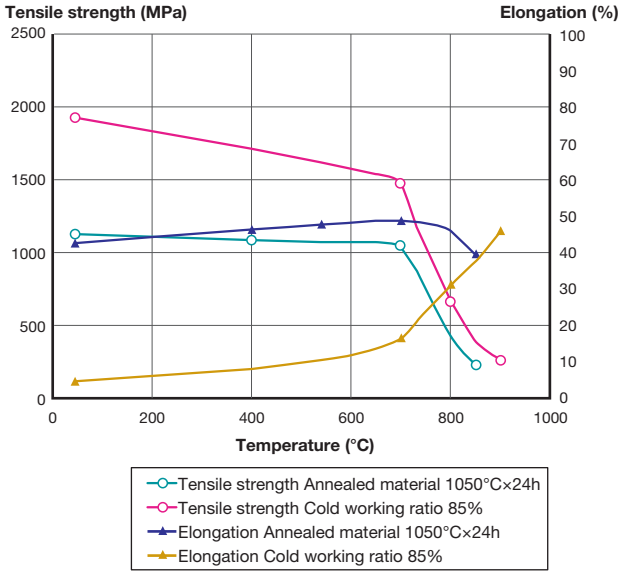
SPRON 510 has excellent characteristics in both high and low temperature ranges.

Low-/high-temperature characteristics

SPRON510 low temperature tensile testing
Relationship between tensile strength and elongation at low temperature



SPRON 510 high temperature tensile testing
Relationship between tensile strength and elongation at high temperature



■ Applications

Evaluated highly for its corrosion resistance and durable quality, SPRON is used for key devises in various field like valves, dental wire, pressure sensor, mass flow controller, and various kinds of fine spring.

- Metal diaphragm and pipe in pressure sensor
- Corrosion-resistant fi ne parts
- Fine parts for medical use
- Several kinds of fi ne spring (coil, torsion, plate)

Pressure sensor, mass flow control device, diaphragm
→ **Strength, corrosion resistance, durability**

Fine springs
→ **Elasticity, durability, corrosion resistance**

SII supplies SPRON as custom-made machined products, featuring its strong characteristics. Mirror surface polishing and fine cutting is possible with SPRON.

SPRON100

Overview

SPRON 100 is a strain age-hardening type Co-Ni alloy that makes the most of the work-hardening properties of cobalt-based alloys. High mechanical strength and corrosion resistance combined with excellent precision processing technologies make it ideal for precision devices, medical precision parts, and precision screws, as well as mechanical watches.

Applications

- Precision springs
  (coils, torsion springs, flat springs, disc springs)
- Springs for measuring instruments
- Cable guides for driving robot devices
- Medical precision parts
- Wires for medical devices

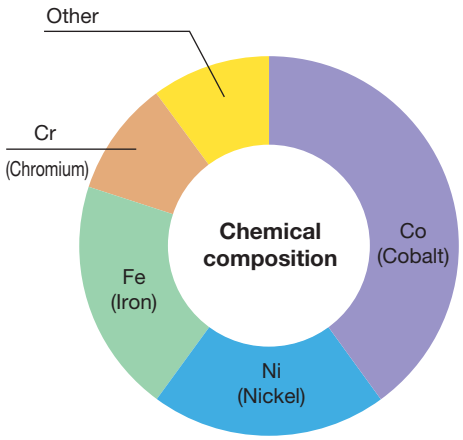
Characteristics

[Mechanical and physical characteristics]

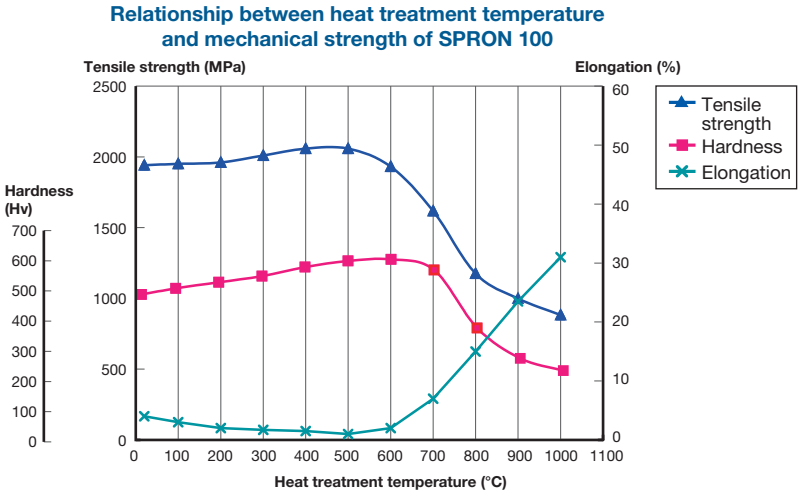
Tensile strength	Elongation	Hardness	Density	Young's modulus	Modulus of rigidity	Linear expansion coefficient (20 to 50°C)	Electrical resistivity
Up to 2156 MPa (Up to 220 kg/mm^2)	3%	Hv. to 600	8.3 to 8.6 g/cm^3	206 to 216 GPa (21 to 22×10^3 kg/mm^2)	80.4 GPa (8.2×10^3 kg/mm^2)	12 to 13×10^{-6} /°C	98 to 100 μΩ-cm

<Measured a wire drawing material with cold processing and age treatment>

Chemical components

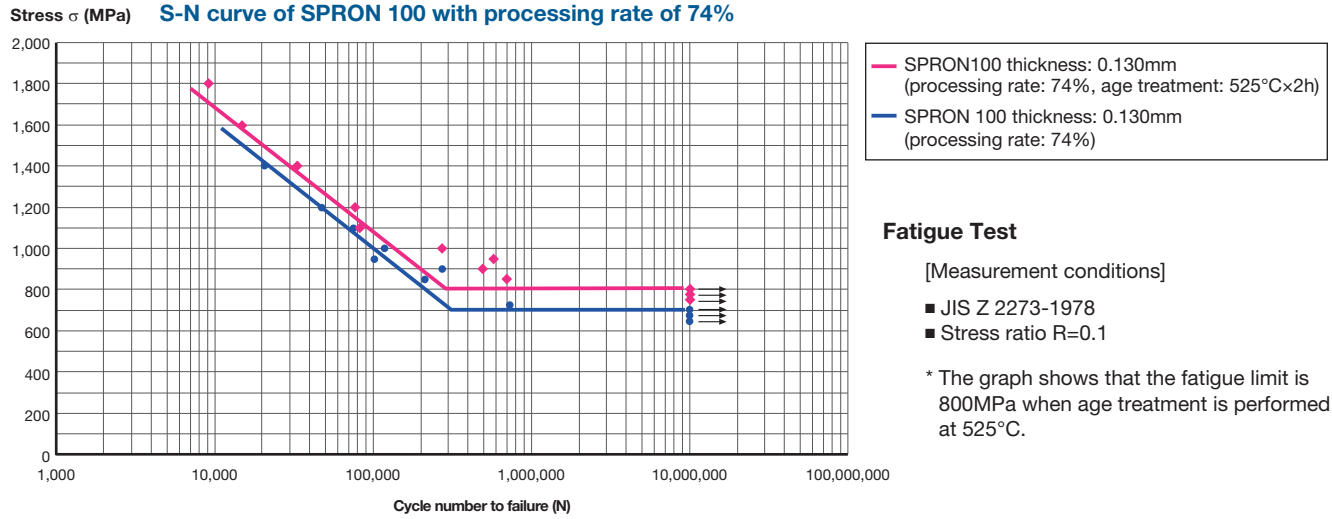


Relationship between mechanical characteristics and heat treatment temperature



* The above graph shows the tensile strength, hardness, and elongation when a material with 90% processing rate of wire-drawing is heat-processed at each temperature for two hours.

S-N curve



Fatigue Test

[Measurement conditions]

- JIS Z 2273-1978
- Stress ratio R=0.1

* The graph shows that the fatigue limit is 800MPa when age treatment is performed at 525°C.

Glossary

Term	Unit	Description
As rolling		Roll drawing has completed.
S-N curves		Graph showing the results of bending fatigue test. (Stress and repetition counts are logarithmically expressed in the vertical and horizontal axes, respectively.)
Stress	MPa	Stress value in fatigue test.
Rate of work		Degree of cold deformation processing, such as wire drawing and rolling. Also known as cold working ratio. The working ratio is the quotient of the sectional area divided by the difference between the sectional areas of the material before and after working, expressed in percentage (%).
Vickers hardness	Hv.	The quotient of the force applied for the indent divided by the surface area of the indent which was produced on the test piece by an indenter (diamond square cone of which angle of opposite faces is 136°).
Strength		Mechanical strength such as tensile strength and hardness
Cycle number to fallure	N	Number of repetitions for fatigue test.
Stiffness	MPa (kg/mm^2)	Maximum stress value in transverse test
Electrical resistivity	μΩ-cm	Electrical resistance ratio specific to a substance
Intensity of magnetization	G	Magnetic flux density in a 5 KOe magnetic field
Aging treatment		Heat processing to improve mechanical characteristics by applying a specified temperature
Coefficient of linear Expansion	1/K (1/°C)	The rate of length change in accordance with the temperature change
Durability		Fatigue characteristics (characteristics resistant against repeated loads)
Corrosion resistance		Durability against corrosive gases and solvent
Heat resistance		Resistance to degredation of characteristics, such as mechanical strength, in a high temperature environment
Young's modulus	GPa (kg/mm^2)	Proportional constant existing between vertical stress and vertical strain
Elasticity		Young's modulus and modulus of rigidity
Heat treatment		Heat application and cooling of metallic materials in appropriate conditions to gain desired characteristics
Non-magnetic material		Property of barely being influenced, if at all, by magnetism
Tensile strength	MPa (kg/mm^2)	Maximum stress value for tensile test
Modulus of relaxation		Relaxation degree due to repeated loading by tensile coil spring model
Poisson's ratio		The ratio of the lateral contraction strain to the longitudinal extension strain when a material is stretched elastically uniaxially.
Modulus of rigidity	GPa (kg/mm^2)	Proportional constant between stress and shear strain when shear force is applied
Cold working		Deformation processing performed at normal temperature

* The above glossary was created based on terms appearing in the SII catalogues and does not certify the contents and products.

Environmental Policy

The Seiko Group recognizes that the preservation of the global environment is one of the most important issues in the world today. We will constantly strive to help realize a sustainable society that will benefit everyone.

1. We are committed to a wide range of environmentally responsible activities, and we will continue to make unceasing efforts to improve our environmental performance, thereby providing increased value for all our stakeholders.
2. We not only comply with all relevant laws and regulations, but also go far beyond legal compliance in our efforts to reduce environmental risks and prevent pollution.
3. Being acutely aware of the part we have to play in mitigating climate change, we are working hard to reduce greenhouse gas emissions.
4. Because we recognize the limits of our precious natural resources, we are increasing our efforts to reuse and recycle every resource possible.
5. We are also working to preserve biodiversity, recognizing that our business activities inevitably affect surrounding ecosystems, and that we also benefit from the health and diversity of those systems.
6. We rigorously ensure proper management of all chemical substances used in production as well as any that are contained in our finished products.
7. We consider the environment throughout the entire life cycle of our products. We are proud that our products and services actively contribute to environmental conservation.
8. Environmental responsibility starts as a management imperative, but to effectively carry out that mission requires the understanding and cooperation of every employee throughout our Group. With that in mind, we are working to raise everyone's environmental awareness so that all of us can work together to protect and nurture our natural environment.
9. Transparency is another part of our social responsibility. We are therefore promoting active disclosure of material information about our environmental activities and promoting increased communication with local, regional, and global stakeholders.
10. In order to derive maximum benefits from these policies, we establish clear environmental targets and strategies to attain them. Then we steadily improve our efforts by constantly re-examining both our targets and our progress towards achieving them.

PRECISION, CRAFTSMANSHIP and MINIATURIZATION

Leveraging Watch Making Technology

With Precision, we apply our Craftsmanship to provide Miniaturization advantages to customers' product development around the world.

Electronic Components and High-performance Materials

SII's electronic components were originally derived from the development and manufacturing of quartz watches.

Since 1953

No corrosion, strong, ultra high elasticity Co-Ni alloy product

"SPRON"

The sophisticated metal product, "SPRON", was born as a material to be used in a "mainspring", which is a drive source of mechanical watches. "SPRON" has been used for over 50 years as a drive source of watches by utilizing its high elasticity, high strength, and high heat resistance. Evaluated highly for its corrosion resistance and durable quality, "SPRON" is used for key devises in various fields.

Since 1975

Small and powerful Silver Oxide Battery

Silver Oxide Battery "SEIZAIKEN"

A small-sized primary battery that features a large electrical capacity and almost no voltage drop until the last stage of electrical discharge even though its minimum diameter is 4 mm. Since the birth of quartz watches, we have developed batteries to increase their electrical capacity. We have also pursued better leakage resistance and long term reliability characteristics. It is expected to be used as a power supply for disposable, wearable, IoT, and the low energy Bluetooth products.

Since 1976

Precise Timing for Electronic Devices

Tuning Fork Quartz Crystal Resonator

Tuning Fork Quartz Crystal Resonators were developed as the basis for accuracy in the Quartz Watch. Our high quality and reliability was prioritized to meet the stringent requirements for watches. Recent demand in IoT developments where devices are required to operate with low power consumption and accurate communication protocol timing have increased the demand for smaller components with the same rugged reliability as is required in watches. For applications which require absolute lowest power consumption, our Timing Crystals are available in our Low CL specifications.

Since 1979

Excellent heat and corrosion resistance

Samarium-cobalt Magnet "DIANET"

"DIANET", which has its origin in rotor magnets of quartz watches, has superior heat resistance and strong magnetic force even though its outside diameter is only 1 mm or less. The Sendai Unit acquired IATF 16949 Quality Management System for the automotive production industry. "DIANET" is used for a wide range of automotive products, and its advanced quality and performance are highly recognized. In addition, "DIANET" is also used in actuators of cameras for smart phones and medical devices.

Since 1988

Stable and reliable

Rechargeable Battery and Capacitor

The rechargeable batteries supporting a wide temperature range of -40˚C to 85˚C are available in our lineup. They are suitable for operating very low power consumption devices, for backup power supply of clock and memory functions of a wide range of products. The capacitor will correspond to the new needs of energy harvesting devices. Capacitors are extremely useful in various applications.

Micro-Energy Division who manufactures the products described in this catalog holds the ISO 9001 quality management system certificate, and the ISO 14001 environmental management systems certificate.

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SPRON Search

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