Superior performance
Co-Ni Alloy Product (SPRON)®

Seiko Instruments Inc.
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.

Creating Time - Optimizing Time - Enriching Time

<table>
<thead>
<tr>
<th>Year</th>
<th>Company Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1881</td>
<td>K. Hattori</td>
</tr>
<tr>
<td>1892</td>
<td>Seikosha</td>
</tr>
<tr>
<td>1917</td>
<td>K. Hattori &amp; Co., Ltd.</td>
</tr>
<tr>
<td>1937</td>
<td>Daini Seikosha Co., Ltd.</td>
</tr>
<tr>
<td>1959</td>
<td>Suwa Seikosha Co., Ltd.</td>
</tr>
<tr>
<td>1963</td>
<td>Seiko Seiko Co., Ltd.</td>
</tr>
<tr>
<td>1966</td>
<td>Seiko Epson Corporation</td>
</tr>
<tr>
<td>1968</td>
<td>Seiko Instruments &amp; Electronics Ltd.</td>
</tr>
<tr>
<td>1970</td>
<td>Seiko Co. Ltd.</td>
</tr>
<tr>
<td>1979</td>
<td>Seiko Instruments Inc.</td>
</tr>
<tr>
<td>1983</td>
<td>Seiko Instruments &amp; Electronics Ltd.</td>
</tr>
<tr>
<td>1985</td>
<td>Seiko Epson Corporation</td>
</tr>
<tr>
<td>1993</td>
<td>Today’s Seiko Time Systems Inc.</td>
</tr>
<tr>
<td>1996</td>
<td>Seiko Clock Inc.</td>
</tr>
<tr>
<td>1997</td>
<td>Seiko Precision Inc.</td>
</tr>
<tr>
<td>1997</td>
<td>Seiko Instruments Inc.</td>
</tr>
<tr>
<td>2001</td>
<td>Today’s Seiko NPC Corporation</td>
</tr>
<tr>
<td>2005</td>
<td>Seiko Watch Corporation</td>
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<tr>
<td>2007</td>
<td>Seiko Holdings Corporation</td>
</tr>
<tr>
<td>2007</td>
<td>Seiko Corporation</td>
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<td>2009</td>
<td>Hattori Seiko Co., Ltd.</td>
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<tr>
<td>2013</td>
<td>Seiko Solutions Inc.</td>
</tr>
<tr>
<td>2017</td>
<td>Seiko Corporation</td>
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It all started with the precision spring. With its evolution came the Co-Ni alloy product that is paving the way of the future.

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]

<table>
<thead>
<tr>
<th>Tensile strength</th>
<th>Stiffness</th>
<th>Elongation</th>
<th>Hardness</th>
<th>Density</th>
<th>Young’s modulus</th>
<th>Modulus of rigidity</th>
<th>Linear expansion coefficient (20 to 50°C)</th>
<th>Electrical resistivity</th>
<th>Intensity of magnetization (5kOe)</th>
<th>Poisson’s ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 2940MPa</td>
<td>Up to 5684MPa</td>
<td>3%</td>
<td>Hv. to 800</td>
<td>8.5 to 8.7 g/cm³</td>
<td>216 to 225GPa</td>
<td>83.3GPa</td>
<td>12 to 13 x 10⁻⁶/°C</td>
<td>98 to 100µΩcm</td>
<td>0</td>
<td>0.33</td>
</tr>
</tbody>
</table>

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

[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

![S-N curve of SPRON510 with processing rate of 73%](image)

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

![Relaxation and Number of repetition due to tensile spring test](image)

Relaxation and Stress due to tensile spring test

![Relaxation and Stress due to tensile spring test](image)
**4. No Magnetization**
SPRON is suitable for parts in measurement/analysis equipment that will not welcome magnetism.

Magnetic characteristic (permeability)

<table>
<thead>
<tr>
<th>Magnetic permeability (μ)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SPRON510</strong></td>
</tr>
<tr>
<td><strong>SUS304</strong></td>
</tr>
<tr>
<td><strong>SUS316</strong></td>
</tr>
</tbody>
</table>

![Graph showing magnetic permeability](image)

* 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 fine parts
- Fine parts for medical use
- Several kinds of fine 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.
**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.

### Chemical composition

- **Cr** (Chromium)
- **Co** (Cobalt)
- **Fe** (Iron)
- **Ni** (Nickel)
- Other

### Characteristics

<table>
<thead>
<tr>
<th>Mechanical and physical characteristics</th>
<th>Tensile strength</th>
<th>Elongation</th>
<th>Hardness</th>
<th>Density</th>
<th>Young’s modulus</th>
<th>Modulus of rigidity</th>
<th>Linear expansion coefficient (20 to 50°C)</th>
<th>Electrical resistivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 2156 MPa (Up to 220 kg/mm²)</td>
<td>3%</td>
<td>Hv. to 600</td>
<td>8.3 to 8.6 g/cm³</td>
<td>206 to 216 GPa (21 to 22-x10^3 kg/mm²)</td>
<td>80.4 GPa (8.2-x10^3 kg/mm²)</td>
<td>12 to 13-x10^-6 /°C</td>
<td>98 to 100 μΩ-cm</td>
<td></td>
</tr>
</tbody>
</table>

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

### 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

### Relationship between heat treatment temperature and mechanical strength of SPRON 100

![Graph showing the relationship between heat treatment temperature and mechanical strength of SPRON 100](image)

- 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

**S-N curve of SPRON 100 with processing rate of 74%**

![Graph showing S-N curve of SPRON 100](image)

**Fatigue Test**

- SPRON100 thickness: 0.130mm (processing rate: 74%, age treatment: 525°C×2h)
- SPRON 100 thickness: 0.130mm (processing rate: 74%)

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

<table>
<thead>
<tr>
<th>Term</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>As rolling</td>
<td>Roll drawing has completed</td>
<td></td>
</tr>
<tr>
<td>S-N curves</td>
<td>Graph showing the results of bending fatigue test. (Stress and repetition counts are logarithmically expressed in the vertical and horizontal axes, respectively.)</td>
<td></td>
</tr>
<tr>
<td>Stress</td>
<td>MPa</td>
<td>Stress value in fatigue test.</td>
</tr>
<tr>
<td>Rate of work</td>
<td>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 (%).</td>
<td></td>
</tr>
<tr>
<td>Vickers hardness</td>
<td>HV</td>
<td>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°).</td>
</tr>
<tr>
<td>Strength</td>
<td>Mechanical strength such as tensile strength and hardness</td>
<td></td>
</tr>
<tr>
<td>Cycle number to failure</td>
<td>N</td>
<td>Number of repetitions for fatigue test.</td>
</tr>
<tr>
<td>Stiffness</td>
<td>MPa (kg/mm²)</td>
<td>Maximum stress value in transverse test</td>
</tr>
<tr>
<td>Electrical resistivity</td>
<td>μΩ-cm</td>
<td>Electrical resistance ratio specific to a substance</td>
</tr>
<tr>
<td>Intensity of magnetization</td>
<td>G</td>
<td>Magnetic flux density in a 5 KOe magnetic field</td>
</tr>
<tr>
<td>Aging treatment</td>
<td>Heat processing to improve mechanical characteristics by applying a specified temperature</td>
<td></td>
</tr>
<tr>
<td>Coefficient of linear expansion</td>
<td>1/K (1/°C)</td>
<td>The rate of length change in accordance with the temperature change</td>
</tr>
<tr>
<td>Durability</td>
<td>Fatigue characteristics (characteristics resistant against repeated loads)</td>
<td></td>
</tr>
<tr>
<td>Corrosion resistance</td>
<td>Durability against corrosive gases and solvent</td>
<td></td>
</tr>
<tr>
<td>Heat resistance</td>
<td>Resistance to degradation of characteristics, such as mechanical strength, in a high temperature environment</td>
<td></td>
</tr>
<tr>
<td>Young’s modulus</td>
<td>GPa (kg/mm²)</td>
<td>Proportional constant existing between vertical stress and vertical strain</td>
</tr>
<tr>
<td>Elasticity</td>
<td>Young’s modulus and modulus of rigidity</td>
<td></td>
</tr>
<tr>
<td>Heat treatment</td>
<td>Heat application and cooling of metallic materials in appropriate conditions to gain desired characteristics</td>
<td></td>
</tr>
<tr>
<td>Non-magnetic material</td>
<td>Property of barely being influenced, if at all, by magnetism</td>
<td></td>
</tr>
<tr>
<td>Tensile strength</td>
<td>MPa (kg/mm²)</td>
<td>Maximum stress value for tensile test</td>
</tr>
<tr>
<td>Modulus of relaxation</td>
<td>Relaxation degree due to repeated loading by tensile coil spring model</td>
<td></td>
</tr>
<tr>
<td>Poisson’s ratio</td>
<td>The ratio of the lateral contraction strain to the longitudinal extension strain when a material is stretched elastically uniaxially.</td>
<td></td>
</tr>
<tr>
<td>Modulus of rigidity</td>
<td>GPa (kg/mm²)</td>
<td>Proportional constant between stress and shear strain when shear force is applied</td>
</tr>
<tr>
<td>Cold working</td>
<td>Deformation processing performed at normal temperature</td>
<td></td>
</tr>
</tbody>
</table>

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

Environmental Activities at Micro-Energy Division

Environment & Quality Policy
Seiko Instruments Inc., Micro-Energy Division is located in Ayashi, a city with beautiful nature, in Miyagi Prefecture. Our aim is to provide customer satisfaction and harmony with the environment through all our products, from Micro battery to other electronic products, and sales activities.

1. We adhere firmly to laws, regulations and customers’ specified requirements.
2. We aim to prevent pollution, to reduce CO₂, and to conserve biodiversity.
3. We set goals, take actions, conduct regular reviews, and improve the system and performance continuously.
4. We contribute to the society by supporting green procurement, developing green products, and promoting green life activity.
5. We adhere to regulations and recommendations regarding Chemical substance content in our products and will promote reduction and replacement.
6. We vigorously educate ourselves and try to engage voluntarily in green life activity.

1. Enrich the line up of Eco-Products
   • We introduced the SII Green Product Label System which is equivalent to the ISO 14021 Type II environmental label. At the end of FY2006, 100% of our products are certified as SII Green Products. In addition, 42 products are certified as SII “High Grade” Green Products.

2. Reduction of Greenhouse Gas
   • We practice various CO₂ reduction measures like using Eco-machines. Since 1997, we have successfully reduced a total of 62,800 tons of CO₂. We believe our efforts contribute to the prevention of global warming.

3. 3R Promotion Activity
   • We have promoted the “reduce and reuse” activities and also promoted recycling at the end of the production process. With these activities, we achieved “Zero-emission” in 2004. We have reduced the non-recyclable wastes to less than 1 ton - less than 1% of our 1997 results.

4. Biodiversity Conservation
   • We endeavor to deepen our understanding on the relevancy between biodiversity and our business activities, and to contribute to the conservation of biodiversity by participating local community activities.

5. Green Purchasing
   • We adhere to a green purchasing campaign through the purchase of ingredients, manufacturing materials, and other necessary products, whenever appropriate.

6. Green Life
   • With the participation of all of Micro-Energy Division members, we deploy a clean-up and beautification campaign in all areas surrounding our factory once a year. In addition, we participate in the clean up activity at Hirose River once a year.

7. Conflict Minerals
   • Recognizing the international importance of conflict minerals issue, we prohibit the use of such minerals.
**Product Introduction**

**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.

- **Stable and reliable Rechargeable Battery & Capacitor**
- **For the IoT product**
- **Precise Timing with Lowest Power consumption**
  - Precise Timing for Electronic Devices
  - Tuning Fork Quartz Crystal Resonator

- **For material used in harsh environments**
- **No corrosion, strong, ultra high elasticity and no magnetization**
- **Superior material "SPRON"**

- **For wearable devices**
- **Excellent heat and corrosion resistance**
- **Samarium-cobalt Magnet "DIANET"**
- **Small and powerful Silver Oxide Battery "SEIZAIKEN"**
Electronic Components and High-performance Materials

SI'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
"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.

Seiko Instruments Inc.
Electronic Components Sales Head Office
1-8, Nakase, Mihamaku, Chiba-shi, Chiba 261-8507, Japan
Telephone:+81-43-211-1735  Facsimile:+81-43-211-8034

Seiko Instruments (H.K.) Ltd.
4-5/F, Wyler Centre 2, 200 Tai Lin Pai Rd.,
Kwai Chung, N.T., Kowloon, Hong Kong
Telephone: +852-2494-5111
Facsimile: +852-2480-5479
Email:sales@sii.com.hk
http://www.sii.com.hk

Seiko Instruments (H.K.) Ltd.
- Shenzhen Rep. Office
Room 2212-15, Office Tower, Shun Hing
Square Di Wang Commercial Centre,
5002 Shen Nan Dong Road, Shenzhen,
518008, China
Telephone: +86-755-8246-2680
Facsimile: +86-755-8246-5140

Seiko Instruments (Shanghai) Inc.
Room 2701-2703, 27th Floor,
Shanghai Plaza,
138 Mid Huaihai Rd.,
Shanghai 200021, China
Telephone: +86-21-6375-6611
Facsimile: +86-21-6375-6727

Seiko Instruments Taiwan Inc.
12F, No.101, Sec.2, Nanking E. Rd.,
Taipei 104, Taiwan, R.O.C.
Telephone: +886-2-2563-5001
Facsimile: +886-2-2563-5580
Email:public@sii.co.jp
http://www.sii.com.tw

Seiko Instruments GmbH
Siemensstrasse 9
D-63263 Neu Isenburg, Germany
Telephone: +49-6102-297-0
Facsimile: +49-6102-297-50100
Email:info@seiko-instruments.de
http://www.seiko-instruments.de

Seiko Instruments U.S.A., Inc.
21221 S. Western Ave., Suite 250,
Torrance, CA 90501, U.S.A.
Telephone: +1-310-517-7802
Facsimile: +1-310-517-7792
Email:info@seikoinstruments.com
http://www.sii-me.com

(Specifications are subject to change without notice.)

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