SII

Superior performance Co-Ni Alloy Product (SPRON)

Product Catalogue 2014

Seiko Instruments Inc.

SPRON solves designers' problems

"SPRON" is a special metal (Co-Ni alloy) developed for mechanical watch springs, through collaboration with the Institute of Materials Research, Tohoku University.
It has the excellent characteristics of high elasticity, durability, corrosion resistance, and heat resistance allowing to be used in wide-range of fields, including medical materials, small precision springs, and metal diaphragms, as well as springs for watches.

CONTENTS

"SPRON" is the SII brand name 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.

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
- Metal diaphragm for special valves
- Medical precision parts
- Wires for medical devices

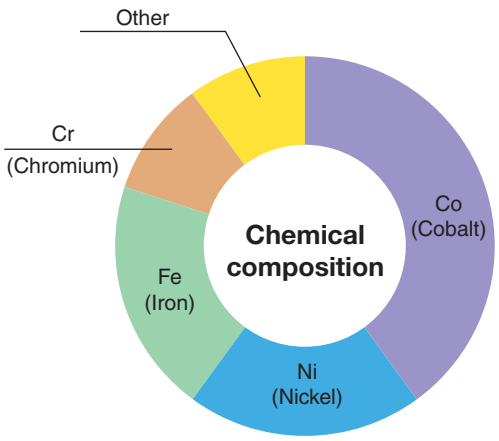
CHARACTERISTICS

Mechanical and physical characteristics

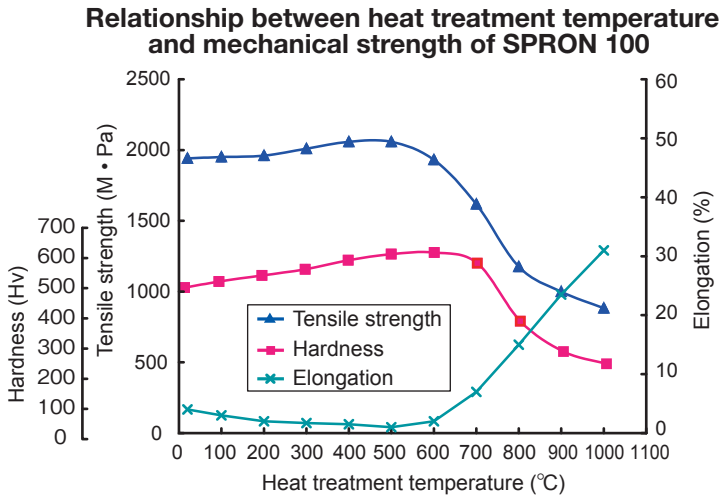
<Measured a wire drawing material with cold processing and age treatment>

Tensile strength	Elongation	Hardness	Density	Young's modulus	Modulus of rigidity	Linear expansion coefficient	Electrical resistivity
Up to 2156MPa (Up to 220kg/mm^2)	3.00%	Hv. to 600	8.3 to 8.6g/cm^3	206 to 216GPa (21 to 22×10^{3}kg/mm^2)	80.4GPa (8.2×10^{3}kg/mm^2)	12 to 13×10^{-6}/°C (20 to 50°C)	98 to 100μΩ-cm

Chemical components

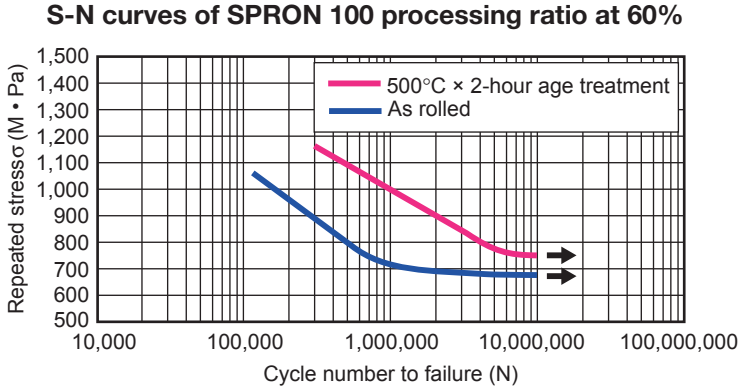


Relationship between mechanical characteristics and heat treatment temperature



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 curves



The above graph shows the S-N curves when rolled materials with a 60% processing rate are bent for fatigue tests. The above graph also shows that the fatigue limit is 750 MPa when age treatment is performed at 500°C.

SPRON510

OVERVIEW

SPRON 510 is a strain age-hardening type Co-Ni-Cr-Mo alloy with material characteristics that are more advanced than SPRON 100.
It is non-magnetic and features ultra high elasticity and high mechanical strength, as well as high durability and heat resistance.

APPLICATIONS

- Metal diaphragms for clean valves
- Metal diaphragms and pipes for mass flow controllers
- Parts for pressure sensors (diaphragms and pipes)
- Corrosion-resistant, precision processed parts
- Precision parts for medical equipment
- Precision springs (coils, torsion springs, flat springs, disc springs)

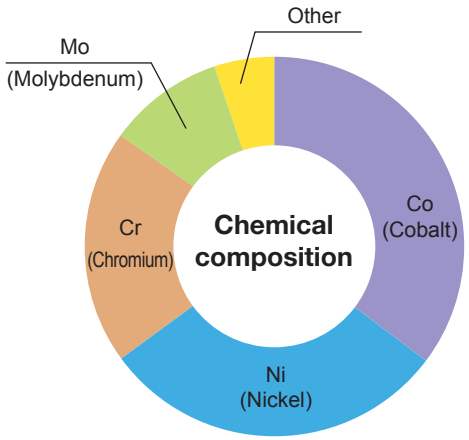
CHARACTERISTICS

Mechanical and physical characteristics

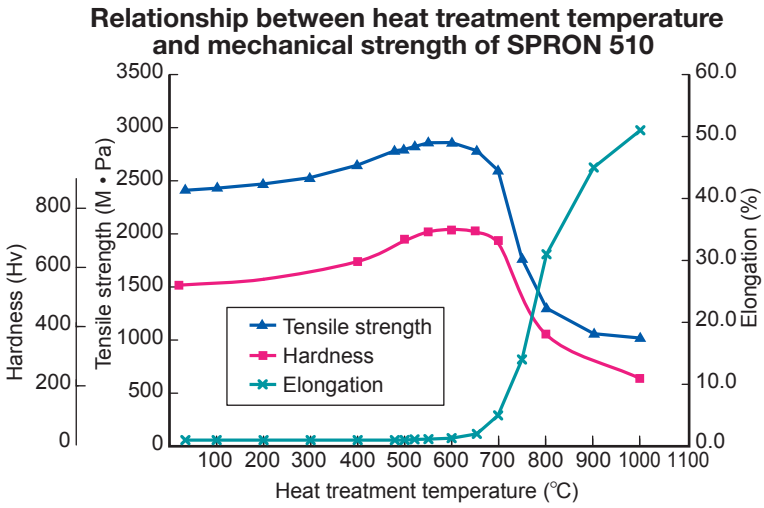
<Measured a wire drawing material with cold processing and age treatment>

Tensile strength	Stiffness	Elongation	Hardness	Density	Young's modulus	Modulus of rigidity	Linear expansion coefficient	Electrical resistivity	Intensity of magnetization	Poisson's ratio
Up to 2940MPa (Up to 300kg/mm^2)	Up to 5684MPa (Up to 580kg/mm^2)	3.00%	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 (20 to 50°C)	98 to 100 μΩ-cm	0 (5kOe)	0.33

Chemical components

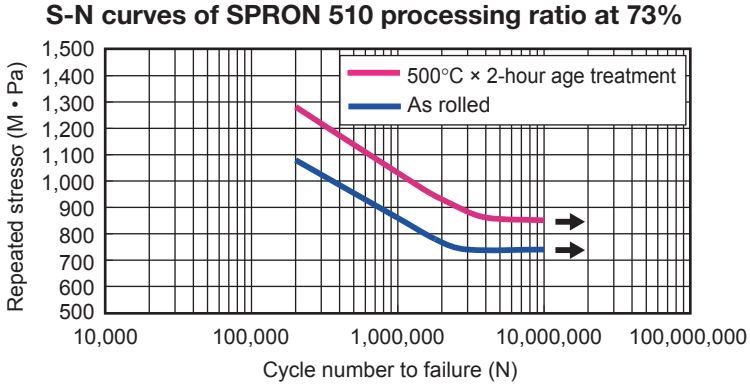


Relationship between mechanical characteristics and heat treatment temperature



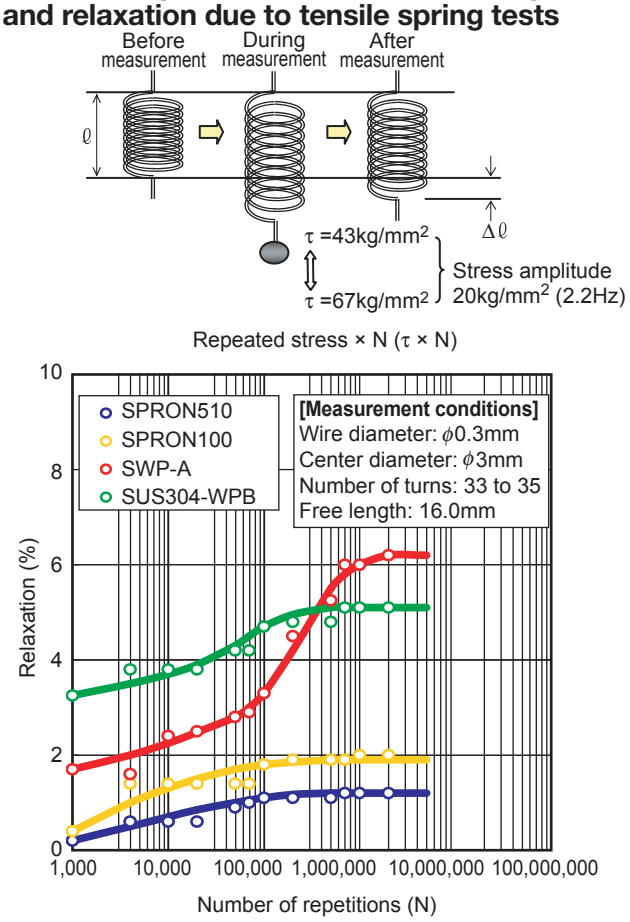
The above graph shows the tensile strength, hardness, and elongation when a material with 90% processing rate of wire-drawing is heat-processed at each temperature for two hours.

S-N curves

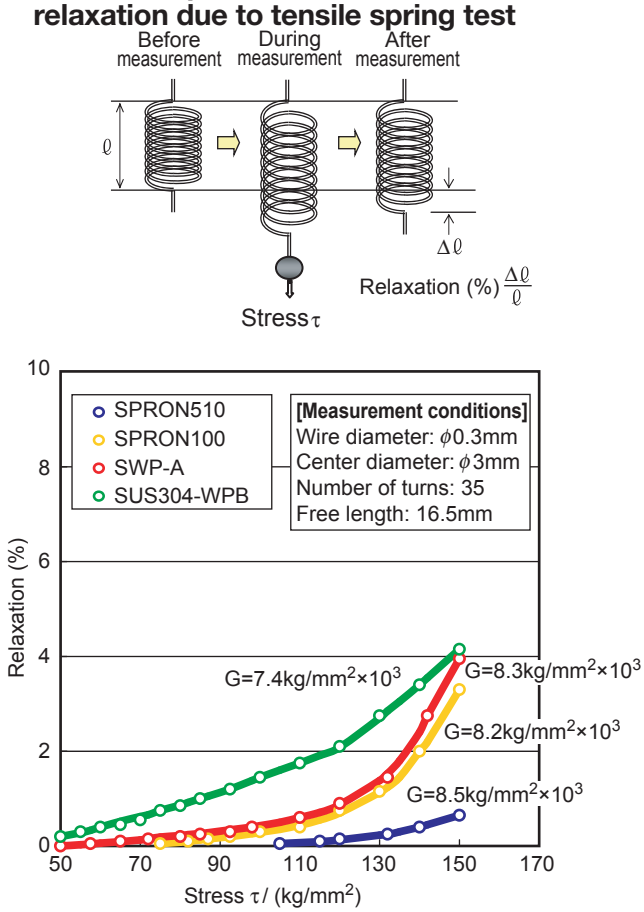


The above graph shows the S-N curves when 0.13mm-thick materials with a 73% processing rate of roll drawing are bent for fatigue tests. The above graph also shows that the fatigue limit is 850 MPa when age treatment is performed at 500°C.

Relationship between number of repetition and relaxation due to tensile spring tests



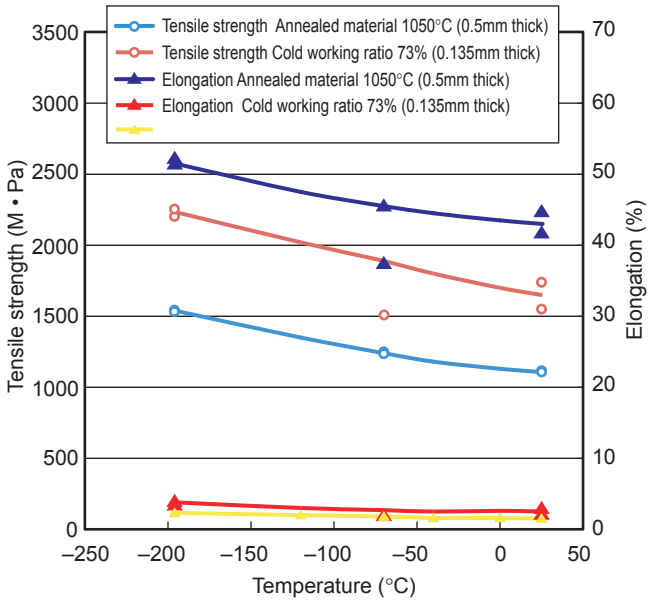
Relationship between stress and relaxation due to tensile spring test



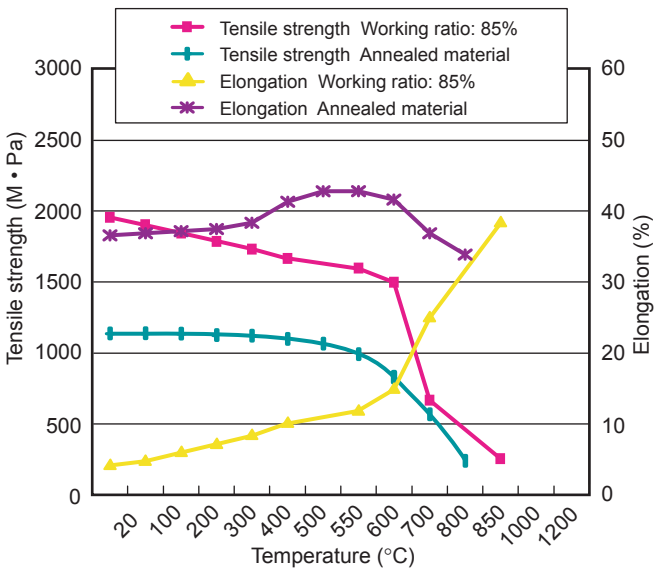
Fatigue due to both statistical and dynamic loads is very small, thus achieving large spring load by a fine spring. High fatigue strength against repetition makes it resistant to fatigue breaking.

Low-/high-temperature characteristics

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



SPRON 510 high temperature tensile testing Wire diameter: φ1.0 mm Relationship between tensile strength and elongation at high temperature

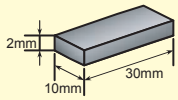


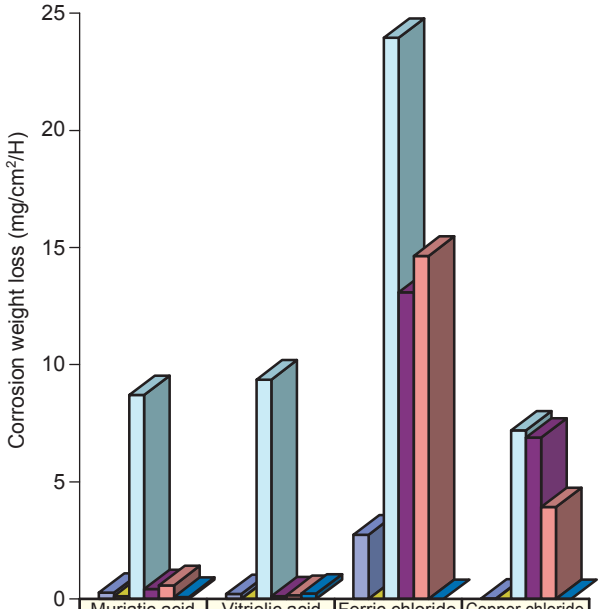
The above shows that SPRON 510 features excellent characteristics in both low and high temperature ranges.

CORROSION TEST DATA & GLOSSARY

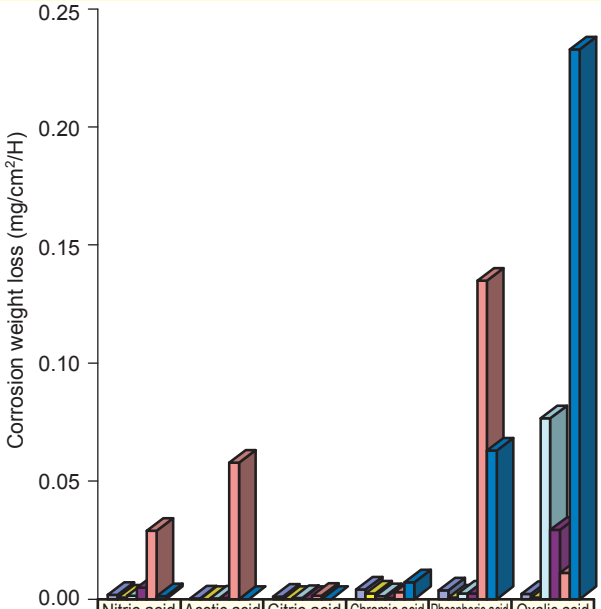
Corrosion Test Results

Annealing temperature of sample: 1100°C × 2 hours
Surface condition of sample: Polished using #1000 paper
Test temperature: 60°C ± 5°C





	Muriatic acid (10%)	Vitriolic acid (10%)	Ferric chloride (10%)	Copper chloride (10%)
SPRON100	0.2710	0.2070	2.7450	0.0098
SPRON510	0.1230	0.0010	0.0007	0.0027
SUS304	8.7020	9.3640	23.9470	7.1904
SUS316L	0.4145	0.1155	13.0786	6.8791
Inconel 600	0.5820	0.1606	14.6450	3.9194
Pure titanium	0.0847	0.2265	0.0029	0.0016



	Nitric acid (10%)	Acetic acid (10%)	Citric acid (10%)	Chromic acid (10%)	Phosphoric acid (10%)	Oxalic acid (10%)
SPRON100	0.0018	0.0002	0.0011	0.0041	0.0037	0.0021
SPRON510	0.0006	0.0000	0.0000	0.0023	0.0006	0.0007
SUS304	0.0015	0.0002	0.0004	0.0012	0.0024	0.0766
SUS316L	0.0048	0.0004	0.0000	0.0004	0.0023	0.0294
Inconel 600	0.0290	0.0578	0.0014	0.0029	0.1348	0.0111
Pure titanium	0.0013	0.0000	0.0000	0.0072	0.0630	0.2328

All data, dimensions, characteristics and values shown in this catalogue are for reference only. Please contact your local Seiko Instruments Representative for current detailed specifications.

GLOSSARY

Term	Unit	Description
As rolling		Roll drawing has completed.
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/mm²)	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
Rate of wire drawing		The rate of drawing is the quotient of the sectional area difference of material before and after working, divided by the sectional area of pre-worked material, expressed in percentage (%).
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/mm²)	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/mm²)	Maximum stress value for tensile test
Modulus of relaxation		Relaxation degree due to repeated loading by tensile coil spring model
Bending stress	MPa	Force in specified area that arises when material is bent
S-N curves for the bending fatigue		Graph showing the results of bending fatigue test (Stress and repetition counts are logarithmically expressed in the vertical and horizontal axes, respectively.)
Modulus of rigidity	GPa (kg/mm²)	Proportional constant between stress and shear strain when shear force is applied
Cold working		Deformation processing performed at normal temperature
Poisson's ratio		The ratio of the lateral contraction strain to the longitudinal extension strain when a material is stretched elastically uniaxially.

* 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 CO_2, 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 recommodations 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.

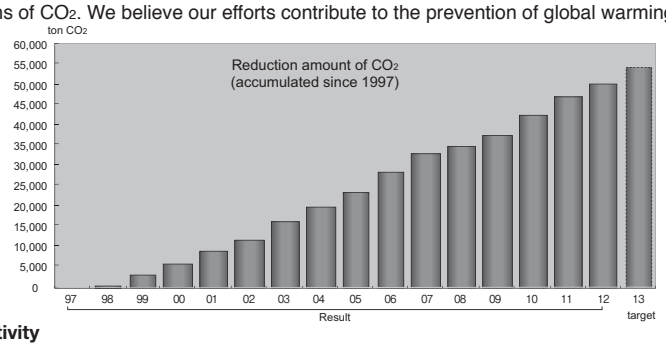
Based on the above policy, the following six environmental approaches are now being implemented throughout Micro-Energy Division.

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, 36 products are certified as SII "High Grade" Green Products.

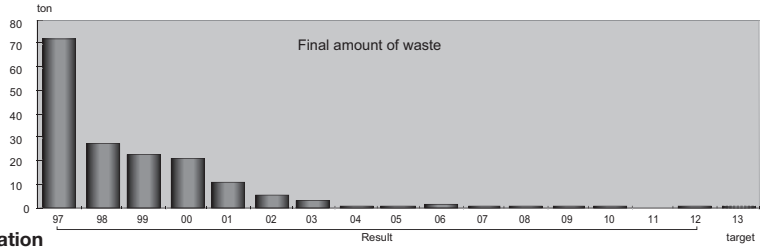
2. Reduction of Greenhouse Gas

- We practice various CO_2 reduction measures like using Eco-machinery. Since 1997, we have successfully reduced a total of 50,300 tons of CO_2. 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 twice 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.

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.

SII

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