

SEMI

CONDUCTOR
MANUFACTURING
EQUIPMENT SOLUTION

55
CASES

Issue Solutions Case Studies

01

Industry Trends and

NBK's Actions

02

By equipment

Search **Issue Solutions and Case Studies**

03

By manufacturing
process

04

By
environment

05

Solving complex problems using
engineering capabilities

Examples of Special Solutions

NBK®

Couplings, Screws, Clampers



This booklet offers
lots of information about our technology to
help you resolve any issues you may have.

Contact us if you still require
additional support.

We are happy to help solve any problems.

Detailed information on our products can be retrieved from the product number on the NBK website.
The QR codes in each section can also be used.

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Discussing important design points for the severe environments within semiconductor manufacturing equipment, such as vacuum, gas, and electron beams.

05 **Solving complex problems using engineering capabilities Examples of Special Solutions** ... 38

Introducing examples of special solutions for various complex problems, based on flexible engineering capabilities.



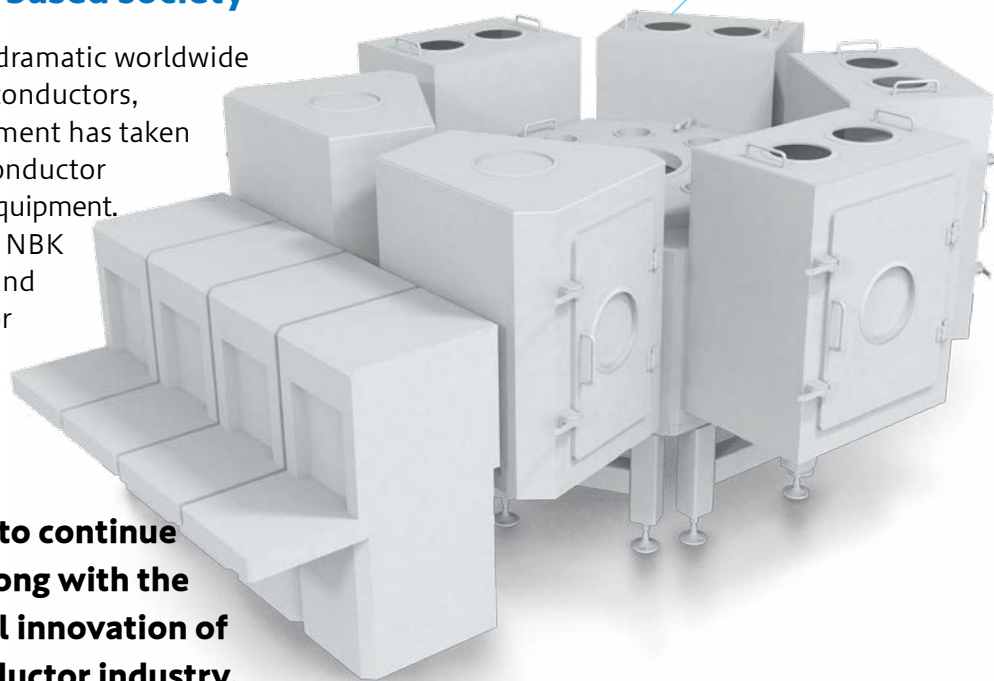
01
Special feature

Industry Trends and NBK's Actions

Semiconductors, the so-called "bread of industry," are essential for the data-based society

Along with the dramatic worldwide growth of semiconductors, similar development has taken place for semiconductor manufacturing equipment. For many years, NBK has developed and sold products for semiconductor manufacturing equipment.

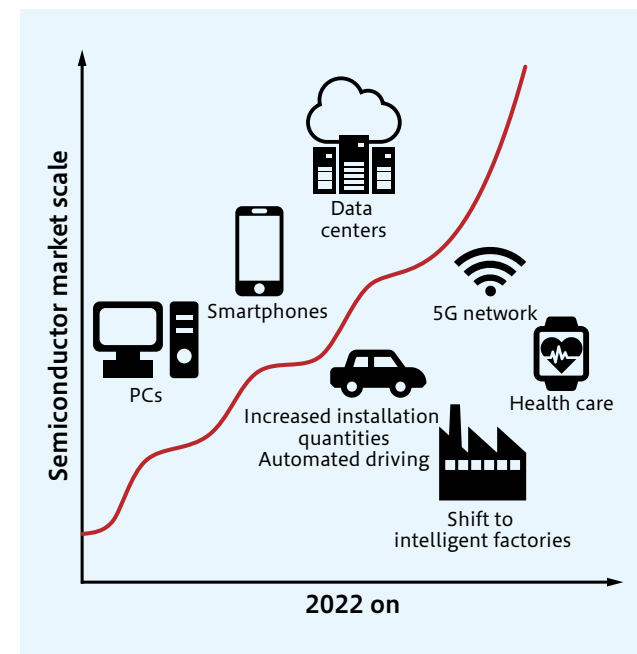
NBK intends to continue its growth along with the technological innovation of the semiconductor industry.



01

Semiconductor industry facts as of 2022

In recent years, due among other things to the novel coronavirus, the shift to a data-based society has picked up speed, including remote work, online classes and medical consultations, video streaming services and so on. Additionally, the demand for semiconductors is expected to increase even further, due to the 5G network, the increase in data centers, the shift to intelligent factories, the increase in semiconductors installed in automobiles and so on.



02

Toward realizing a carbon-neutral society

Semiconductors' evolution is a source of expectations toward realizing a carbon-neutral society. In order to realize this carbon-neutral society, energy-saving in every field, via devices using semiconductors, is an essential step. Higher semiconductor performance and greater mass production are urgent issues.



Therefore, semiconductor manufacturing equipment
**is surely also called on for
higher precision, higher quality, and greater throughput.**

Semiconductor manufacturing issues resolved by NBK

As semiconductor manufacturing equipment tends toward increased precision, quality, and throughput, special requests for the screws used in the equipment are increasing as well. NBK offers a wide lineup including characteristics such as corrosion resistance, heat resistance, non-magnetism and so on, responding to various requests. In addition, NBK handles everything from requests from semiconductor manufacturing equipment manufacturers through product development and standardization.

High Quality
High Precision
High Throughput

Request example 01

Screws with seizing prevention which will not contaminate a vacuum chamber are required

Customer Comments

“In the clean environment inside vacuum chambers, the friction coefficient of male and female screws goes up, increasing the likelihood of screw seizing and galling, which causes problems. Surface coated screws, the conventional seizing/galling countermeasure, cannot be used because of the risk of contamination due to coating peeling. Screws with seizing prevention which will not contaminate vacuum environments are required.”

Surface Hardened Screws (SUS316L)

SNSL-PN



Here Development of Special Surface Hardened Screws

Galling and seizing are prevented by curing the screw surface. Unlike plating or coating, there is nothing adhering to the surface, eliminating concerns about contamination due to stripping when tightening.

Surface Hardened Screws (With Ventilation Hole)

SVSL-PN



Request example 02

Screws with higher corrosion resistance than Hastelloy

Customer Comments

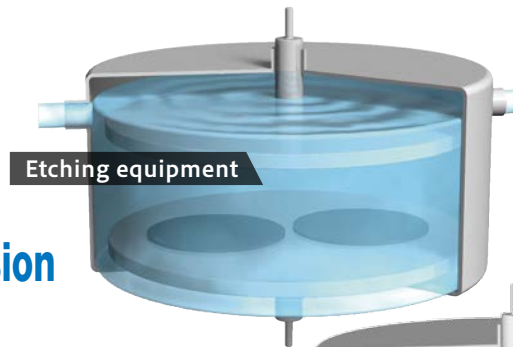
“Etching equipment and coating equipment sometimes use more corrosive plasma gas than in the past, so that even the Hastelloy screws now in use corrode and cause problems.”

Here Production of MAT21 screws

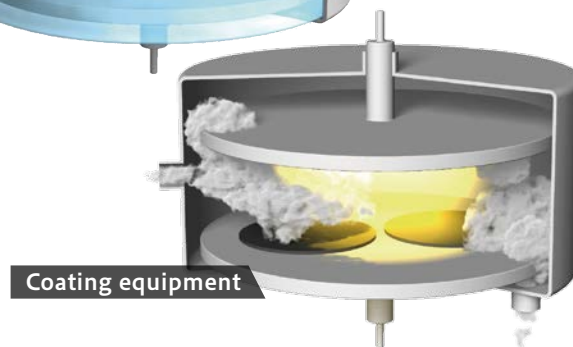
MAT21*1 demonstrates excellent corrosion resistance in both oxidizing and reducing environments. In a wide range of corrosive environments, it demonstrates better corrosion resistance than Hastelloy*2C-22 and C-276.

*1: MAT and MAT21 are registered trademarks of Hitachi Metals, Ltd. *2: Hastelloy is a registered trademark of Haynes International, Inc.

Etching equipment



Coating equipment



Hex Socket Head Cap Screws (MAT21)

SNSMT



Request example 03

Screws with higher strength than resin which will not corrode due to cleaning agents

Customer Comments

“Environments inside wafer cleaning equipment, exposed to cleaning agents, require chemical resistance and thus generally use plastic parts. However, tightening force is required in some locations, calling for the use of stronger metal screws rather than plastic screws. That said, standard metals will corrode or melt when exposed to cleaning agents. Screws made of materials with high chemical resistance and high strength are required.”

Wafer cleaning equipment



Here Development of tantalum and silicon carbide screws

Tantalum is a material characterized by excellent chemical resistance; with excellent corrosion resistance to strong acids such as sulfuric acid, it is also resistant to aqua regia. Silicon carbide has excellent resistance to chemicals, including ammonia water, hydrogen peroxide water, hydrofluoric acid, and 50% sulfuric acid.

Surface Hardened Screws (Tantalum)

SNSTA



Slotted Pan Head Screws (Silicon Carbide)

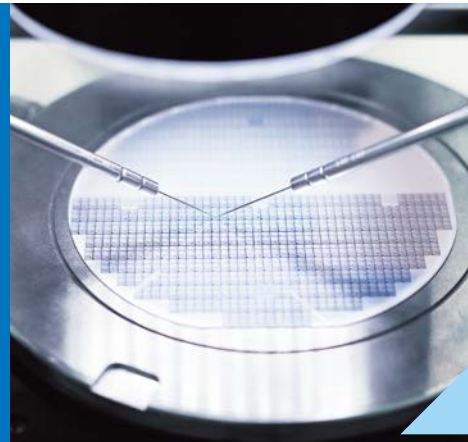
SICX-SX



02

Search Issue Solutions and Case Studies by equipment

Explanations of how to handle special environments such as vacuum, high temperatures, and chemical adherence, sorted by equipment and processes.



1

Equipment interior overall

01 Tools that can be used even in narrow working spaces are required

Learn More → P.8



02 Tools that can be used even in locations where magnetization must be avoided are required

Learn More → P.9



03 Devices must be firmly connected

Learn More → P.9



04 Screws that will not affect communication are required

Learn More → P.10



05 Improved coupling insulation properties are required

Learn More → P.10



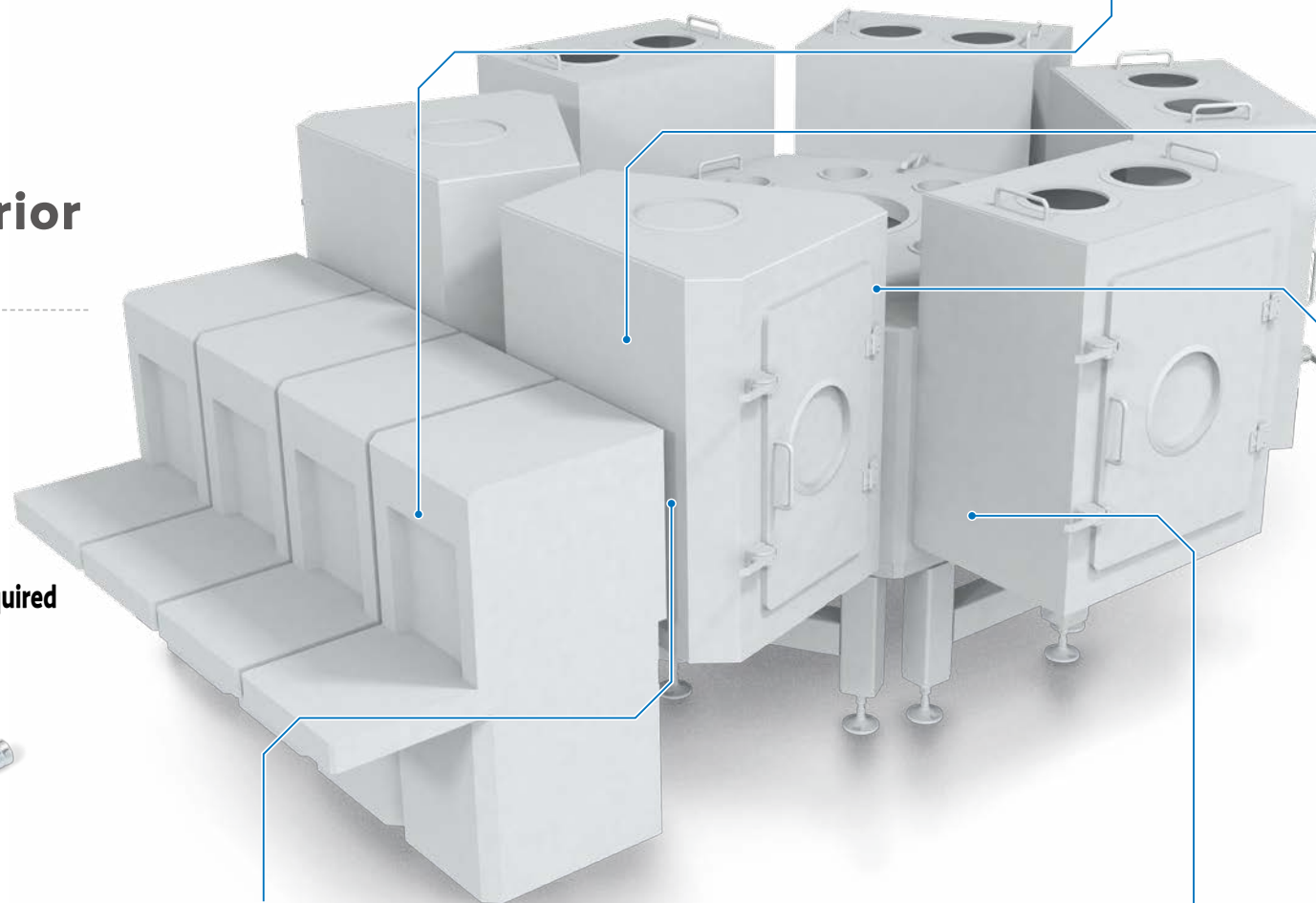
06 Screws that can be used in limited spaces are required

Learn More → P.11



07 High-speed control of raising / lowering shafts, suppressing hunting, is required

Learn More → P.11

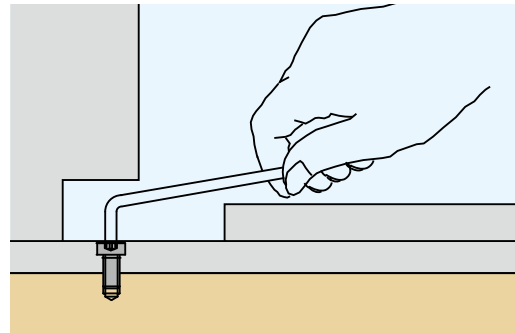
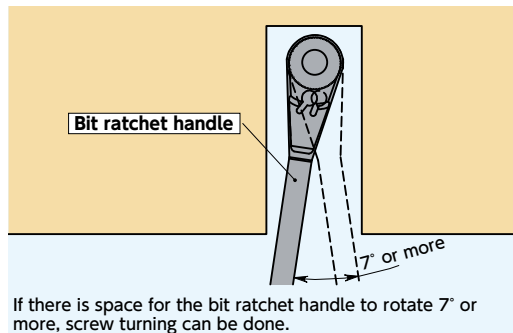
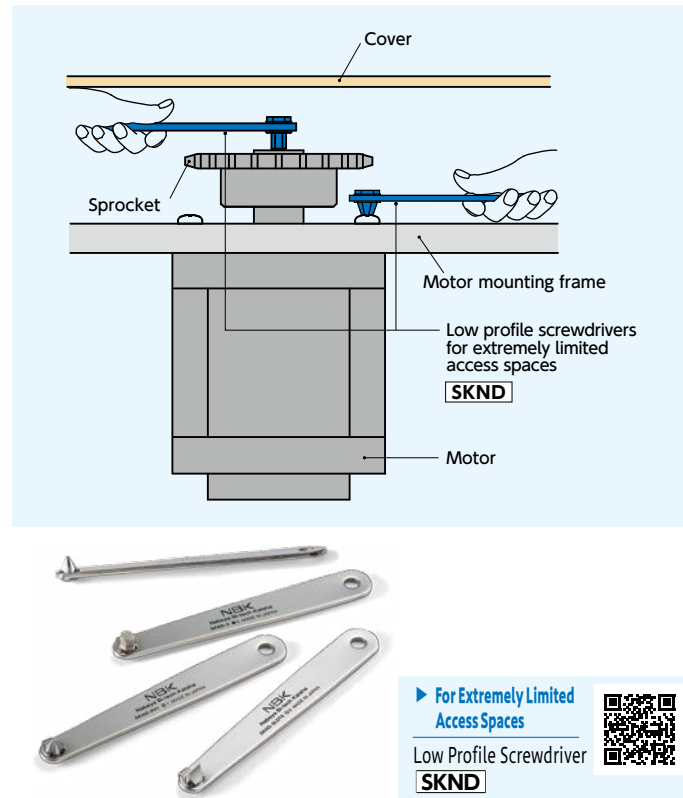


Q:01

Tools that can be used even in **narrow working spaces** are required

A: Tools optimized for working in narrow spaces are available

Tools with reduced height dimensions are available. Required working space is decreased, so device/equipment structure can also be made more compact.



Q:02

Tools that can be used even in locations where **magnetization must be avoided** are required

A: Non-magnetic tools are available

Suitable for assembly and maintenance of equipment and devices in environments with strong magnetic fields. They can also be used on devices for which magnetization must be avoided.



Non-magnetic
Titanium Hexagon Key
SKHTG



Non-magnetic
CERTP Adjustable Wrench
SKMWCP-200



Q:03

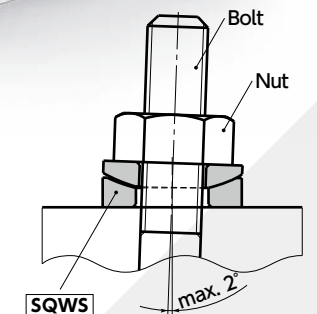
Devices must be **firmly connected**

A: Washers which can correct an alignment mismatch between the bolt and seating surface, occurring frequently when connecting equipment, are available

When connecting two pieces of equipment, the use of spherical washers absorbs any bolt tilting, enabling reliable fastening.



Spherical Washers
SQWS



Q:04

Screws that **will not affect communication** are required

A: Solutions with plastic screws of various shapes and materials

Conventional metal screws may affect LoadPort and FOUN communication. The use of plastic screws prevents disruption to communications.



► PEEK
Plastic Screws
SPE

► PPS
Plastic Screws
SPS

► PTFE
Plastic Screws
SPT

Q:05

Improved coupling insulation properties are required

A: Couplings with high insulation performance are available

Oldham couplings do not have sufficient insulation, so a larger size is required. PEEK couplings can be used to improve insulation at the same size. Special sizes can also be manufactured.



► PEEK
Slit Couplings
MSXP-C-W-SP

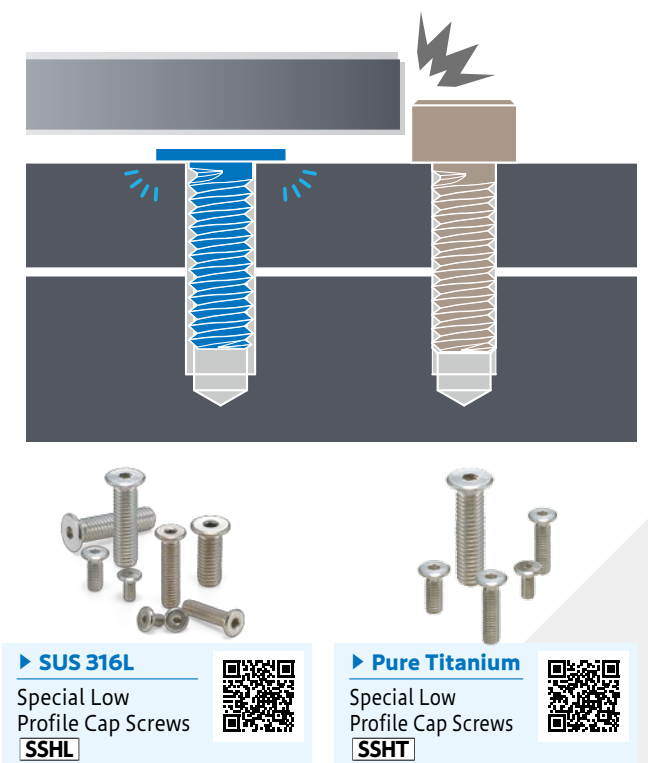
Q:06

Screws that **can be used in limited spaces** are required

A: Screws with extremely thin heads are available

Products made of highly corrosion-resistant SUS316L, pure titanium, and so on are also available. Manufacturing is possible using materials not available among the standard products, such as Hastelloy and Inconel.

* Hastelloy is a registered trademark of Haynes International, Inc.
* Inconel is a registered trademark of Special Metals Corporation.



► SUS 316L
Special Low Profile Cap Screws
SSHL

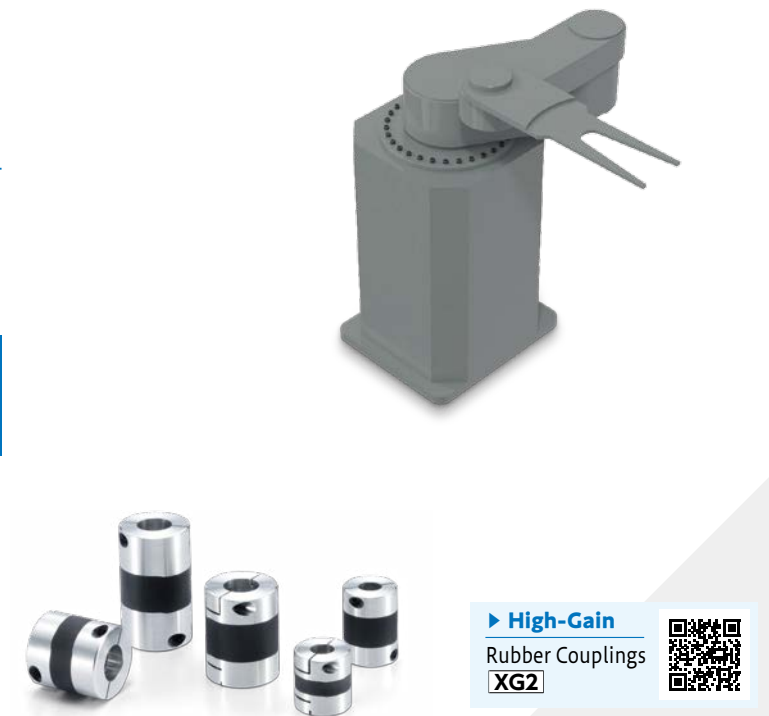
► Pure Titanium
Special Low Profile Cap Screws
SSHT

Q:07

High-speed control of raising / lowering shafts, suppressing hunting, is required

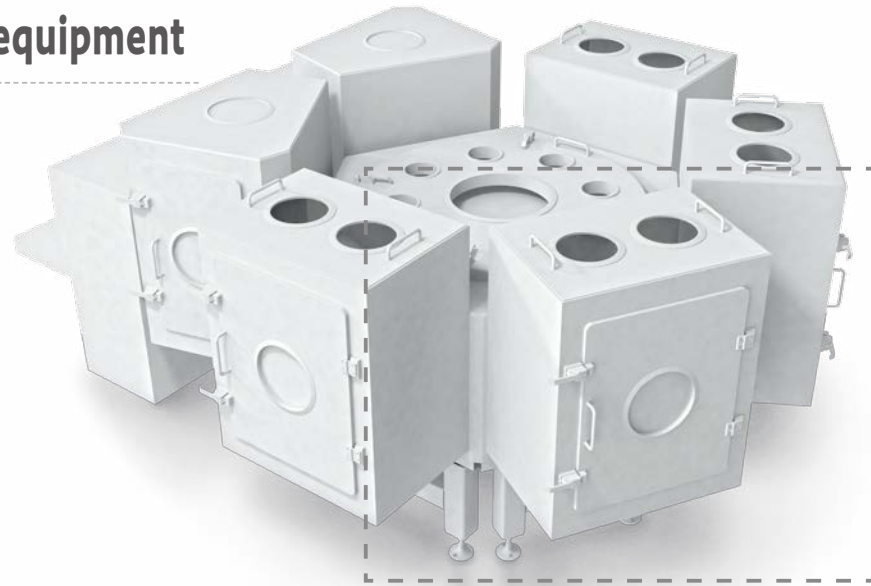
A: Couplings that suppress vibration are effective

Vibration often occurs while raising and lowering when using conventional metal couplings. High-gain rubber couplings can be used to achieve high-speed raising and lowering with excellent vibration absorption.



► High-Gain
Rubber Couplings
XG2

2 Vacuum chambers within equipment



01 Increased **degree of vacuum** in equipment is required

Learn More → P.14



02 Screws that can **retain wafers** are required

Learn More → P.14



03 Screws in **places unreachable by hand** need to be tightened

Learn More → P.15



04 **Washer fallout must be prevented**

Learn More → P.15



05 Reinforcement is required for places where **bolts are frequently removed**

Learn More → P.16



06 Screws that retain **high strength even in high-temperature environments** are required

Learn More → P.16



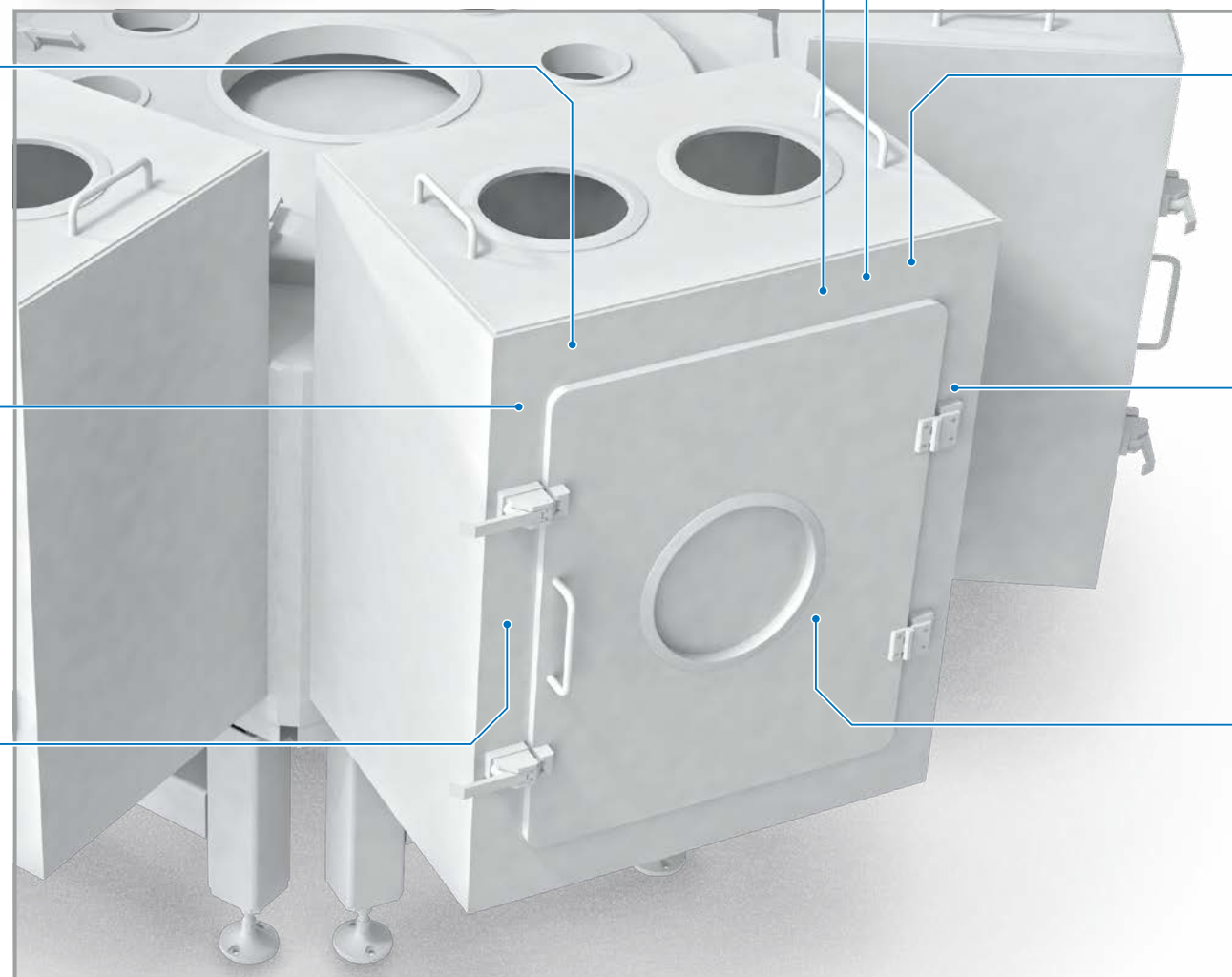
07 **Stainless steel screws** must be prevented from galling / seizing

Learn More → P.17



08 Screws must be **protected from chemicals**

Learn More → P.17

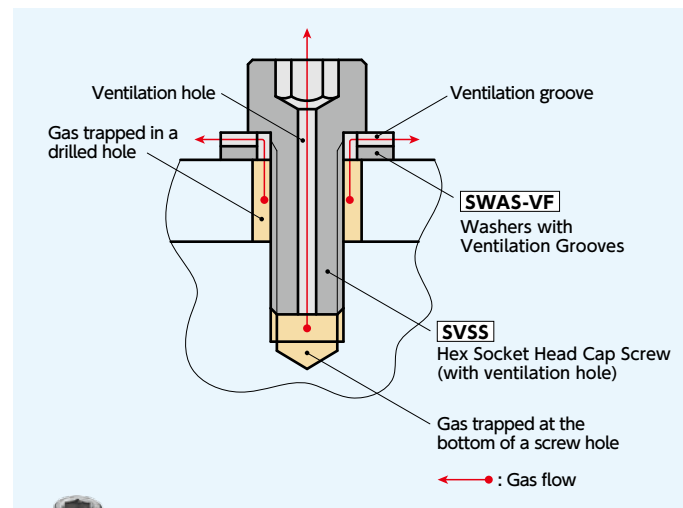


Q:01

Increased **degree of vacuum** in equipment is required

A: Screws which support equipment vacuuming are available

Screws that support the evacuation of gas trapped in the bottom of screw holes or drilled holes are available.



► Screws for Vacuum Equipment



► Washer Integrated High Strength

Vacuum Screws
SVSQLG



► MoS2 Shot

SVSS-MOS

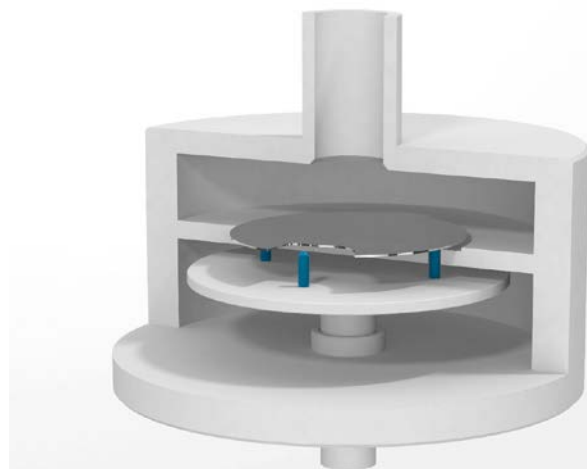


Q:02

Screws that can **retain wafers** are required

A: Screws with ceramic ball tips are available

Clamping screws with ceramic ball tips are available. Made of ceramic, they have excellent heat resistance. Special products with different main body materials can also be manufactured.



► Ceramic Balls
Clamping Screws
SCSS-CE



Q:03

Screws in **places unreachable by hand** need to be tightened

A: Tools with screw holding function are available

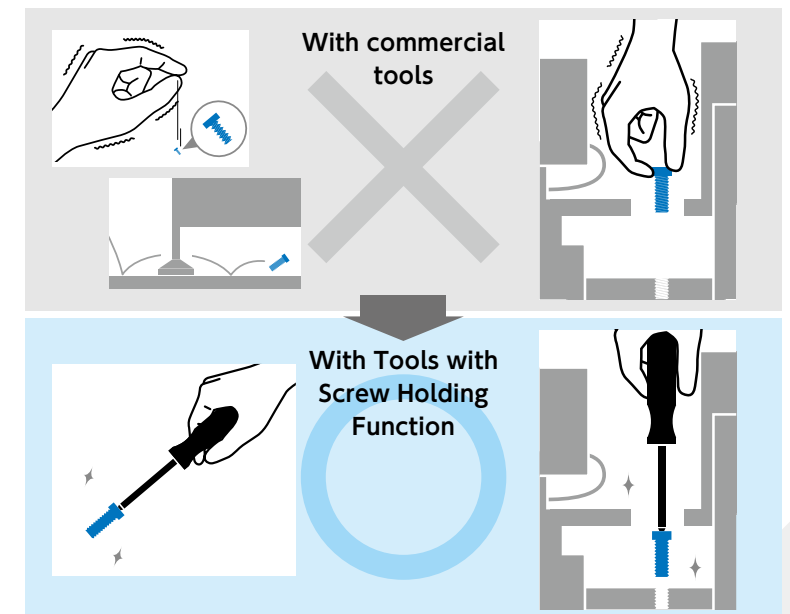
Tools which retain hex socket head cap screws are available. Ideal for narrow spaces where screws cannot be retained by hand during assembly/maintenance of equipment, or for preventing screws from falling into devices during maintenance.



► Hexagon Screwdrivers
With Screw Holding Function
SKCD



► Hex Sockets
With Screw Holding Function
SKCK



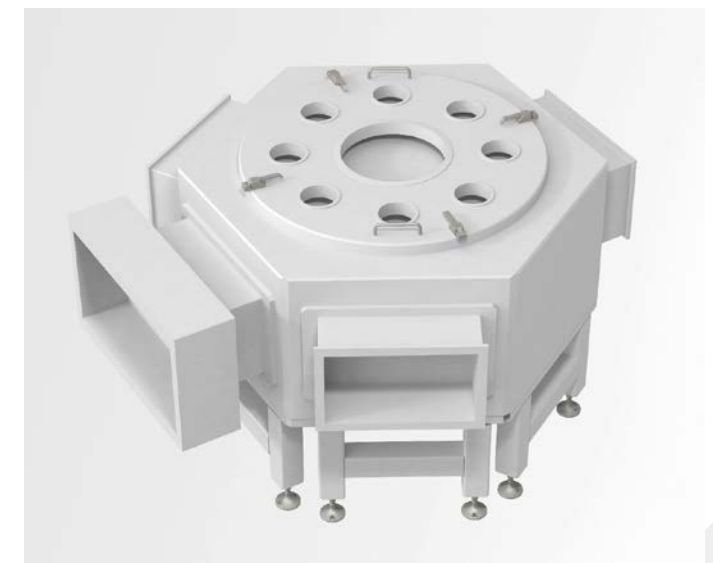
Q:04

Washer **fallout must be prevented**

A: The use of integrated washer type screws is recommended

Integrated washer type screws are available in order to prevent washer fall-out during equipment assembly or maintenance. Washer loss inside vacuum chambers, etc., can be prevented. Manufacturing is possible using materials not available among the standard products, such as Hastelloy and Inconel.

* Excludes spring washers.
* Hastelloy is a registered trademark of Haynes International, Inc.
* Inconel is a registered trademark of Special Metals Corporation.



► High Strength SUS
High Performance
Stainless Steel Screws
SNSQLG



► High Strength SUS
Vacuum Screws
SVSQLG

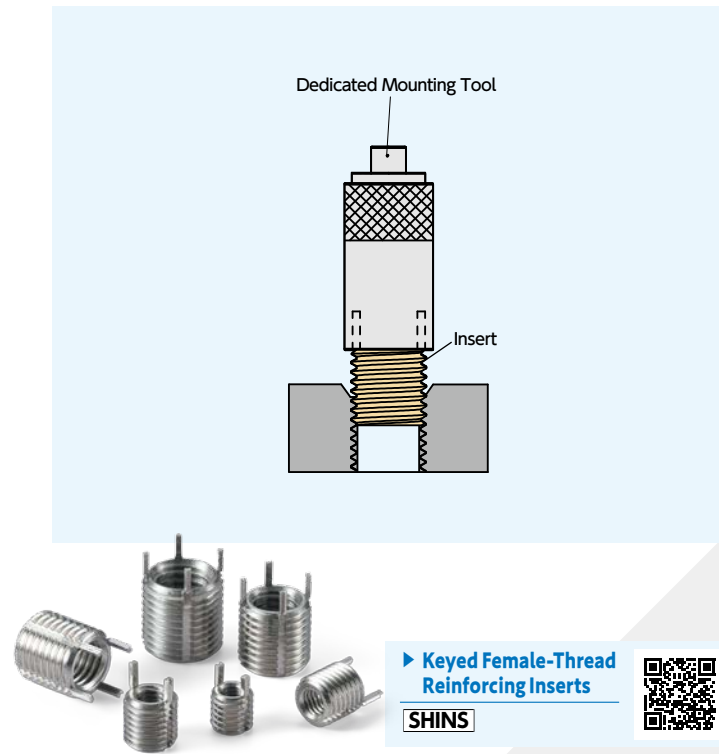


Q:05

Reinforcement is required for places where **bolts are frequently removed**

A: Female threads can be reinforced by using an insert

Keyed female-thread reinforcing inserts are available. These high-strength stainless steel integrated types can be used for firm fastening or in areas where bolts are frequently fastened and removed. Ideal for reinforcing female threads in resin, aluminum, or quartz, as well as for repairing damaged female threading. Coil-type inserts and special surface treatment specifications are also available.



Q:06

Screws that retain **high strength even in high-temperature environments** are required

A: We offer screws with excellent heat resistance

Screws made from various heat-resistant materials are available. Select according to the operating environment.

Material	Tensile Strength (N/mm ²)			
	200°C	500°C	800°C	1000°C
SUS316L	560	500	250	—
SUS310S	580	500	200	—
Inconel 600 equivalent	560	530	200	70
Molybdenum	590	450	290	210
Carbon Steel	450	230	40	—
SUS304	500	420	160	—

* Inconel is a registered trademark of Special Metals Corporation.



Q:07

Stainless steel screws must be prevented from galling/seizing

A: Screws with optimal surface treatments for vacuum chamber use are available

Special Surface Hardened Screws prevent screw galling and seizing. Unlike plating or coating, there is nothing adhering to the surface, eliminating concerns about contamination due to stripping when tightening.



Q:08

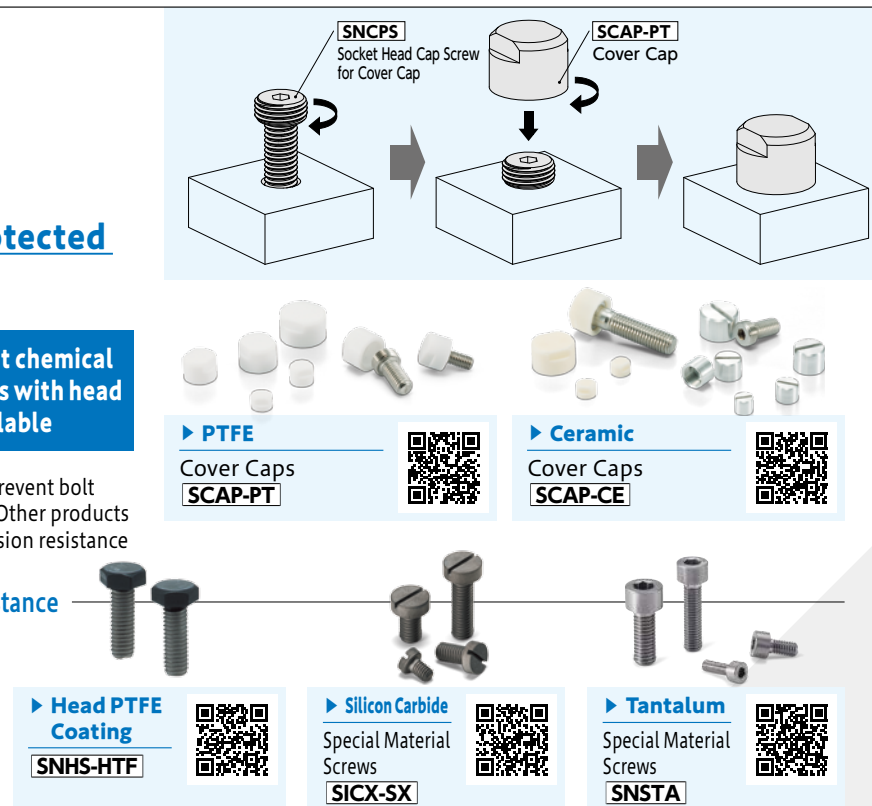
Screws must be **protected from chemicals**

A: Screws with excellent chemical resistance and screws with head coating only are available

Covers made of PTFE or ceramic prevent bolt head corrosion due to chemicals. Other products use materials with excellent corrosion resistance to chemicals such as sulfuric acid.

► **To enhance chemical resistance**

Products with a head coating of 50 μm film thickness PTFE are also available. Other products use materials with the same excellent corrosion resistance to chemicals such as sulfuric acid.



3 Equipment exterior

01 Touch panel operation without wobbling is required

Learn More → P.20



03 Only certain workers should be able to remove screws

Learn More → P.21



02 CE marking compliance is required

Learn More → P.20



04 Products conforming to SEMI standards are required

Learn More → P.21



Q:01

Touch panel operation without wobbling is required

A: We offer Display Mounting Systems which are unlikely to deviate even in environments subject to vibration

The built-in spring serves to retain the display. Tightening after adjustment is not necessary.

► Display Mounting Systems

Spring Retention
DFT-PB



► Display Mounting Systems

**Monitors need to be movable with one touch in accordance with the worker's height or the nature of the work**

A: Parts enabling free adjustment of the monitor position are available

Available display mounting systems include options for various mounting locations, while available parts enable position changes with a single touch of a button.



► Display Mounting Systems

DTAC-AB-A



► Positioning Brackets

CUAB-A



Q:03

Only certain workers should be able to remove screws

A: Screws requiring dedicated tools for removal are available

Tampering can be prevented by using these screws where only certain workers should be able to remove screws.



► Tamper Resistant

Button Head Cap Screws with Three-Lobe Holes
SRSAS



► Tamper Resistant

Special Low Profile Cap Screws
SRSHS



► Tamper Resistant

Flat Head Bolts with Hexalobular Sockets
SRFXS



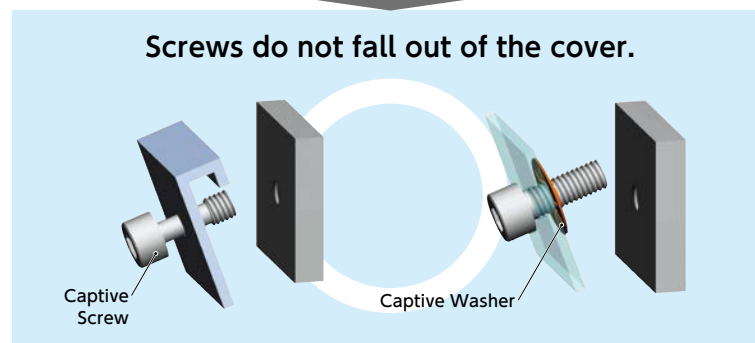
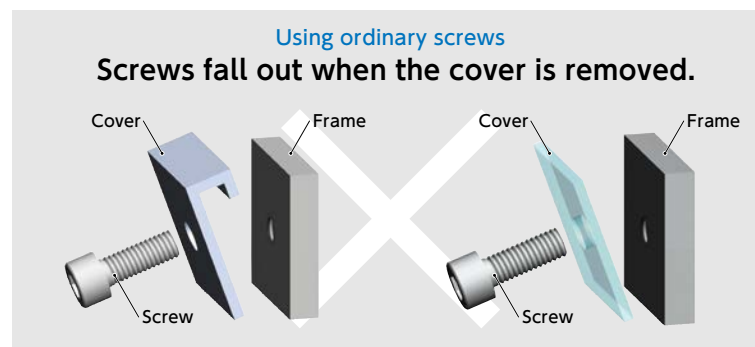
Q:02

CE marking compliance is required

A: Screws which don't fall out when the cover is removed are available

Fixed guards must be fixed by systems that can be opened or removed only with tools. The use of captive screws enables compliance with CE marking.

► Captive Series



Q:04

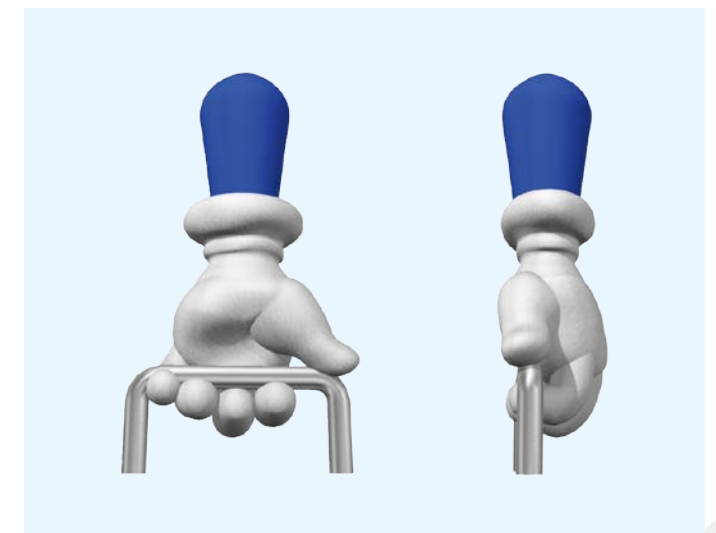
Products conforming to SEMI standards are required

A: An abundant lineup of SEMI standard compliant products are available for selection

The SEMI standard recommends the use of handles conforming to the Supplier Ergonomic Success Criteria (SESC) standard, in order to create a safe, comfortable, and convenient working environment.



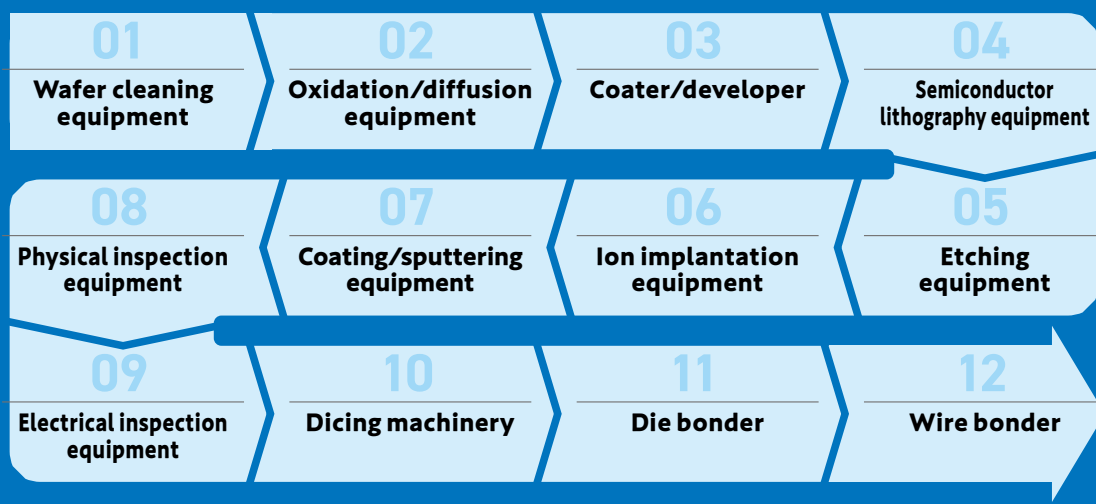
► SEMI Standard Compliant Products



03

Search Issue Solutions and Case Studies by manufacturing process

Because equipment interior environments vary widely by process in semiconductor manufacturing, the performance required of machinery and parts also differs by equipment and process. Here we present case studies of issue solutions by process and equipment.



01. Wafer cleaning machinery

Cleaning process

▶ Component corrosion prevention is required

Screws with superior chemical resistance can be selected to withstand environments within equipment where chemicals are applied.

Characteristics required for special screws: **Chemical resistance**



▶ **Silicon Carbide**
Special Material Screws
SICX-SX



▶ **Tantalum**
Special Material Screws
SNSTA



▶ **Ceramic**
Special Material Screws
SCX



▶ **PEEK**
Plastic Screws
SPE



▶ **VESPEL**
Plastic Screws
SPDC



02. Oxidation/diffusion equipment

Heat treatment/oxidation/diffusion process

▶ Resistance to high temperatures and chemicals is required

For environments where various gases are used at high temperatures, screws with excellent heat resistance and chemical resistance are effective.

Characteristics required for special screws: **Heat resistance**
Chemical resistance

▶ **Tantalum**
Special Material Screws
SNSTA



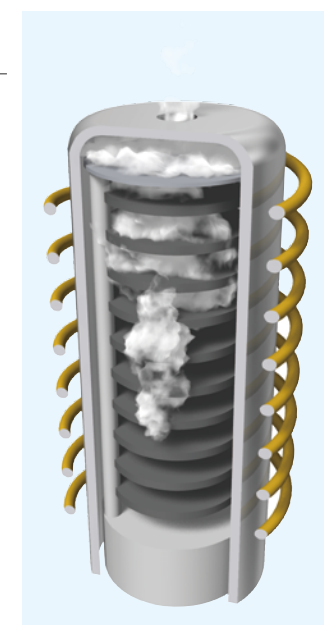
▶ **MAT21**
Special Material Screws
SNSMT



▶ **Inconel 600 equivalent**
Special Material Screws
SNSI



* Inconel is a registered trademark of Special Metals Corporation.



03. Coater/developer

Film formation process

▶ Improved production capacity is required

High-rigidity couplings are effective for the high-speed rotation required for photoresist film formation on the wafer.

Characteristics required for couplings: **High rigidity**



▶ **High Rigidity**
Disk Coupling
XHW-C



▶ **Vibration-Absorption Capable Disk Type**
Flexible Couplings
XGHW-C



▶ Component corrosion prevention is required

Screws with superior chemical resistance can be selected to withstand environments within equipment where chemicals are applied.

Characteristics required for special screws: **Chemical resistance**

▶ **Inconel 600 equivalent**
Special Material Screws
SNSI



▶ **VESPEL**
Plastic Screws
SPDC



* Inconel is a registered trademark of Special Metals Corporation.

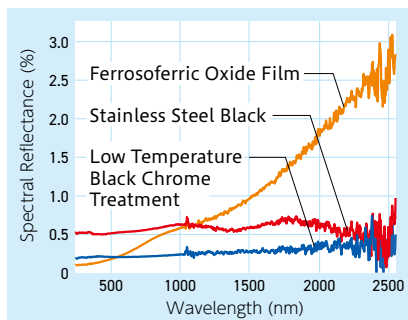
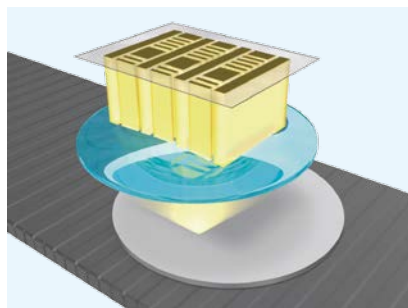
104. Semiconductor/lithography equipment

Photolithography process

► Improved equipment accuracy is required

Even the small screws used at joints enable exposure accuracy to be improved by suppressing the influence of reflection.

Characteristics required for special screws: **Anti-reflection**



► Low Temperature Black Chrome Treatment

Special Surface Treated Screws
SNSS-RY



► Stainless Steel Black

Special Surface Treated Screws
SNSS-BK



105. Etching equipment

Etching process

► Motor damage must be prevented

Components with excellent insulating properties are required as a countermeasure to prevent energization from vacuum variable capacitors.

Characteristics required for couplings:

Insulating properties

► Resistance to high temperatures and chemicals is required

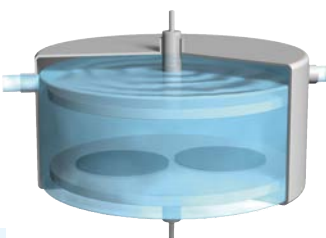
For environments where various gases and solvents are used at high temperatures, screws with excellent heat resistance and chemical resistance are effective.

Characteristics required for special screws:

Heat resistance **Chemical resistance**

► PEEK

Slit Couplings
MSXP-C-W-SP



► MAT21

Special Material Screws
SNSMT



► Hastelloy C-276

Special Material Screws
SNSH-C276



* Hastelloy is a registered trademark of Haynes International, Inc.

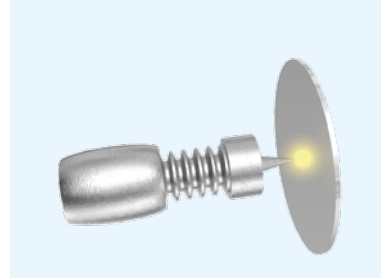
► Cover Caps

Chemical Resistant Screws
SCAP-PT



106. Ion implantation equipment

Ion implantation process



► Improved degree of vacuum is required

The degree of vacuum can be further improved by removing air trapped within the screw hole.

Characteristics required for special screws: **Vacuum**



► Washer Integrated High Strength

Vacuum Screws
SVSQLG



► Screws that don't gall at high temperatures are required

We have screws that prevent galling due to heat cycling in environments of 1000°C or higher.

Characteristics required for special screws: **Heat resistance**



► Tantalum

Special Material Screws
SNSTA



► Improved equipment accuracy is required

Non-magnetic components are effective as fasteners to prevent ions from deflecting due to the magnetic properties of the part.

Characteristics required for special screws: **Non-magnetic**



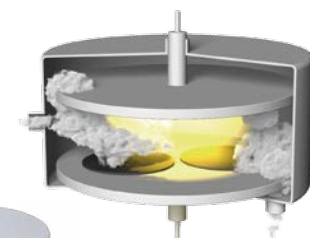
► 64 Titanium

High-Strength Titanium Screws
SNSTG



107. Film deposition equipment/sputtering equipment

Film formation process



► Motor damage must be prevented

Components with excellent insulating properties are required as a countermeasure to prevent energization from vacuum variable capacitors.

Characteristics required for couplings:

Insulating properties



► PEEK

Slit Couplings
MSXP-C-W-SP



► Fully Customized Multi-functional Components

Flexus



► Resistance to high temperatures and chemicals is required

For environments where various gases are used at high temperatures, screws with excellent heat resistance and chemical resistance are effective.

Characteristics required for special screws:

Heat resistance **Chemical resistance**



► Molybdenum

Special Material Screws
SVSM



► Nickel

Special Material Screws
SNSN



► Hastelloy C-22

Special Material Screws
SVSH-C22



* Hastelloy is a registered trademark of Haynes International, Inc.

08. Physical inspection equipment

Inspection/evaluation process

► Improved degree of vacuum is required

The degree of vacuum can be further improved by removing air trapped within the screw hole.

Characteristics required for special screws: **Vacuum**



► Pure Titanium

Vacuum Screws
SVST



► Special Chemical Polish

Vacuum Screws
SVSS



► Special Low Profile Cap Screws

Vacuum Screws
SVSHS



► Increased inspection accuracy is required

Non-magnetic screws which do not distort electron beams are available.

Characteristics required for special screws:

Non-magnetic

► **64 Titanium**
High-Strength Titanium Screws
SNSTG



► **Tantalum**
Special Material Screws
SNSTA



► **Phosphor Bronze**
Special Material Screws
SNSP



09. Electrical inspection equipment

Inspection/evaluation process

► More compact equipment is required

We have small diameter screws of M2.6 and less, including S0.6 up and M1 up.

Characteristics required for special screws: **Space-saving**



► Captive Screws

Special Low Profile Cap Screws
SSCHS



► Miniature Screws

For Precision Instruments
SNS



10. Dicing machinery

Dicing process

► Improved productivity is required

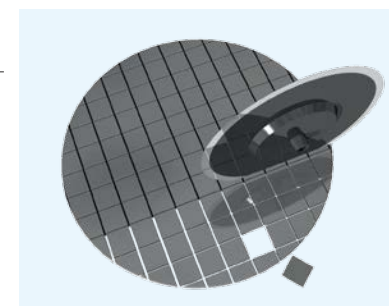
High-strength components and components increasing the rigidity of the equipment can be used to improve equipment responsiveness.

Characteristics required for couplings: **High gain support**



► High-Gain

Rubber Couplings
XG2



11. Die bonder

Mounting process

► Achieves high-speed bonding

Realizes even greater servomotor gain, leading to reduced stabilization time.

Characteristics required for couplings: **High gain support**



► High-Gain

Rubber Couplings
XG2



► Prevents components from loosening due to vibrations

High-strength screws achieve greater fastening strength than regular screws, and consequently have loosening-preventing effects.

Characteristics required for special screws: **High strength**



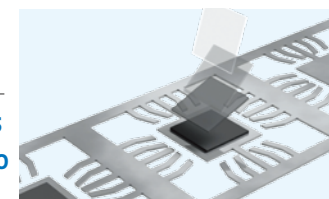
► Washer Integrated High Strength

Vacuum Screws
SVSQLG



► 64 Titanium

High-Strength Titanium Screws
SNSTG



12. Wire bonder

Bonding

► Achieves high-speed bonding

Realizes even greater servomotor gain, leading to reduced stabilization time.

Characteristics required for couplings:

High gain support



► High-Gain

Rubber Couplings
XG2



Products which reduce dynamic load by lightening equipment weight are available.

Characteristics required for special screws: **Lightweight** **Space-saving**



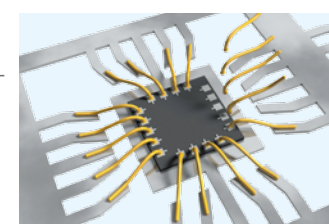
► SUS

Special Low Profile Cap Screws
SSHHS



► Pure Titanium

Special Low Profile Cap Screws
SSHT



04 Search Issue Solutions and Case Studies by environment

Discussing important design points for various special environments, such as vacuum, gas, and electron beams.

01 Vacuum environments	29
02 Process gas and wafer cleaning agents	30
03 Electron beams and ions	31
04 Preventing part fall-out	32
05 Increasing throughput	34
06 Thermal cycling	36



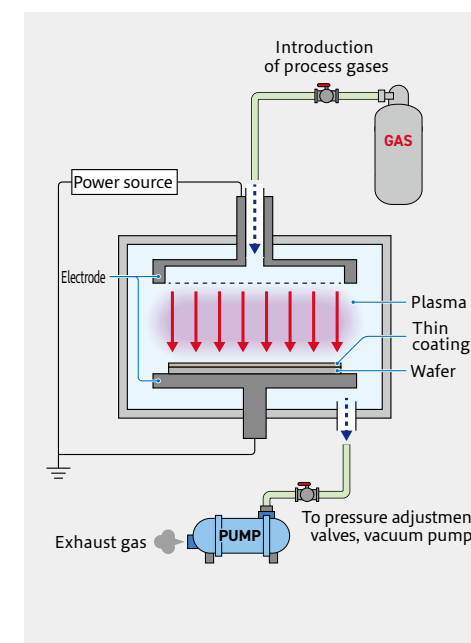
01 Vacuum environments

Vacuum technology is used widely in semiconductor manufacturing equipment. Vacuum is necessary mainly in equipment using plasma and electron beams, not in every piece of equipment.

Boxes/rooms which are made into vacuum environments using vacuum pumps are called vacuum chambers.

Why is vacuum required in semiconductor manufacturing equipment?

- To reduce impurities and enhance reaction quality**
Processes like coating and etching are performed in low-impurity vacuum to enabling higher-quality processing.
- To lower the boiling point**
The lower boiling point enables wafer processing at lower temperatures. Suppressing temperature changes helps prevent wafer deformation. Additionally, it eliminates the need to use high-temperature-resistant materials and specifications for the manufacturing equipment.
- To generate plasma**
Low pressure means lower power required for excitation. Additionally, plasma can be generated with various gas types.



Vacuum classification

There are actually various different types of vacuum.

Low vacuum	100kPa to 100Pa
Medium vacuum	100Pa to 0.1Pa
High vacuum	0.1Pa to 10 ⁻⁵ Pa
Ultra-high vacuum	10 ⁻⁵ Pa or less

NBK offers optimal products for use in vacuum environments



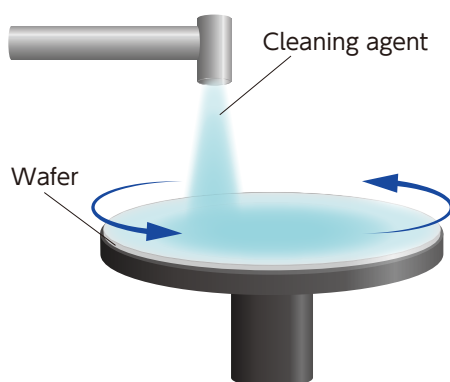
02 Process gas and wafer cleaning agents

Process gases (a special kind of gas) and cleaning agents (for removing impurities) are often used in semiconductor manufacturing processes.

What are process gases?

Inert gases and special gases (collectively referred to as "process gases") are often used in semiconductor manufacturing processes including the film formation and etching processes. Some gases can even corrode stainless steel materials such as SUS304.

Monosilane	Silicon tetrachloride	Silicon tetrafluoride	CFC-116
Phosphorus pentafluoride	Arsine	Disilane	CFC-218
CFC-32	Tungsten hexafluoride	Phosphine	Boron trifluoride
Hydrogen bromide	Nitrous oxide	CFC-22	Diborane
Boron trichloride	Chlorine	Trichlorosilane	CFC-123
Germane	Hydrogen chloride	Chlorine trifluoride	Titanium tetrachloride
Dichlorosilane	Ammonia	CFC-14	HF
Hydrogen selenide	Nitrogen trifluoride	CFC-23	Phosphorus trifluoride



What are wafer cleaning agents?

There are also processes where special cleaning agents are used to clean dirt and minute impurities from wafers. Cleaning agents such as SPM (sulfuric acid hydrogen peroxide water solution) and FPM (hydrofluoric acid hydrogen peroxide water solution) may even dissolve stainless steel and other metals.

<Examples of cleaning agents>	SPM (sulfuric acid hydrogen peroxide water solution)
SC-1 (ammonia hydrogen peroxide water solution)	FPM (hydrofluoric acid hydrogen peroxide water solution)
SC-2 (hydrochloric acid hydrogen peroxide water solution)	BHF (buffered hydrofluoric acid solution)

NBK offers chemical resistant screws with excellent corrosion resistance

They can be used even in environments where they may be exposed to process gas or wafer cleaning agents.

See here for our full lineup of chemical resistant screws ▶▶▶



* Chemical resistance changes with usage conditions. Always carry out tests under performance conditions similar to actual conditions in advance.



03 Electron beams and ions

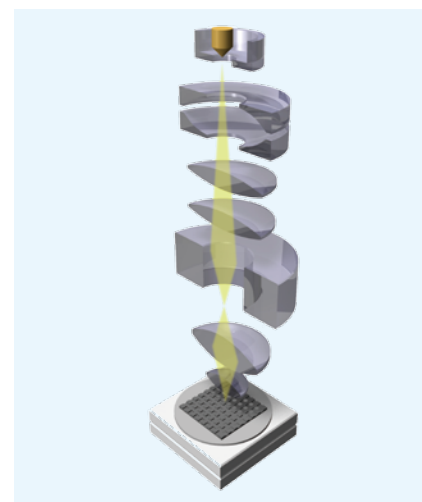
Semiconductor manufacturing equipment includes equipment using electron beams and ions.

Equipment using electron beams and ions

Typical equipment examples include

- Electron beam lithography equipment
- Electron beam exposure equipment
- Scanning electron microscopes
- Ion implantation equipment

These equipment types use large quantities of low-magnetism parts in order to avoid affecting the electron beams or ions. Furthermore, because electron beams are used in vacuum environments in order not to collide with airborne molecules, many types of equipment include vacuum chambers.



NBK offers non-magnetic products

Full lineup of non-magnetic screws here ▶▶▶



▶ 64 Titanium
High-Strength Titanium Screws
SNSTG



▶ Phosphor Bronze
Special Material Screws
SNSP



▶ Tantalum
Special Material Screws
SNSTA



Tools for locations where magnetization is to be avoided are also available.



▶ Non-magnetic
Titanium Hexagon Key
SKHTG



▶ Non-magnetic
CFRT Adjustable Wrench
SKMWCP-200



04 Preventing part fall-out

Part fall-out

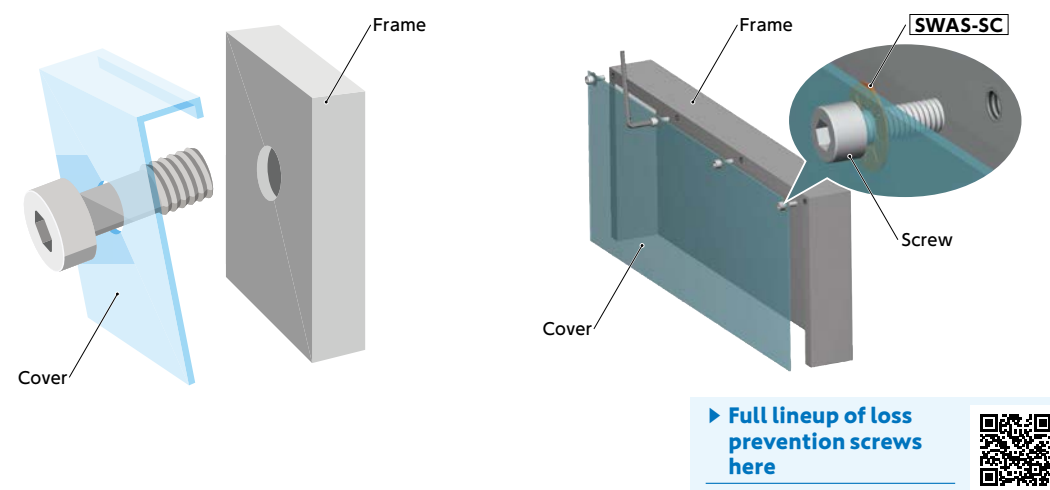
The interior of semiconductor manufacturing equipment is an extremely complex space. A single screw or washer falling into the equipment during assembly or maintenance can affect its quality, requiring a painstaking search.

Screws with integrated washers are available

There is no concern needed for washer fall-out during assembly or maintenance.

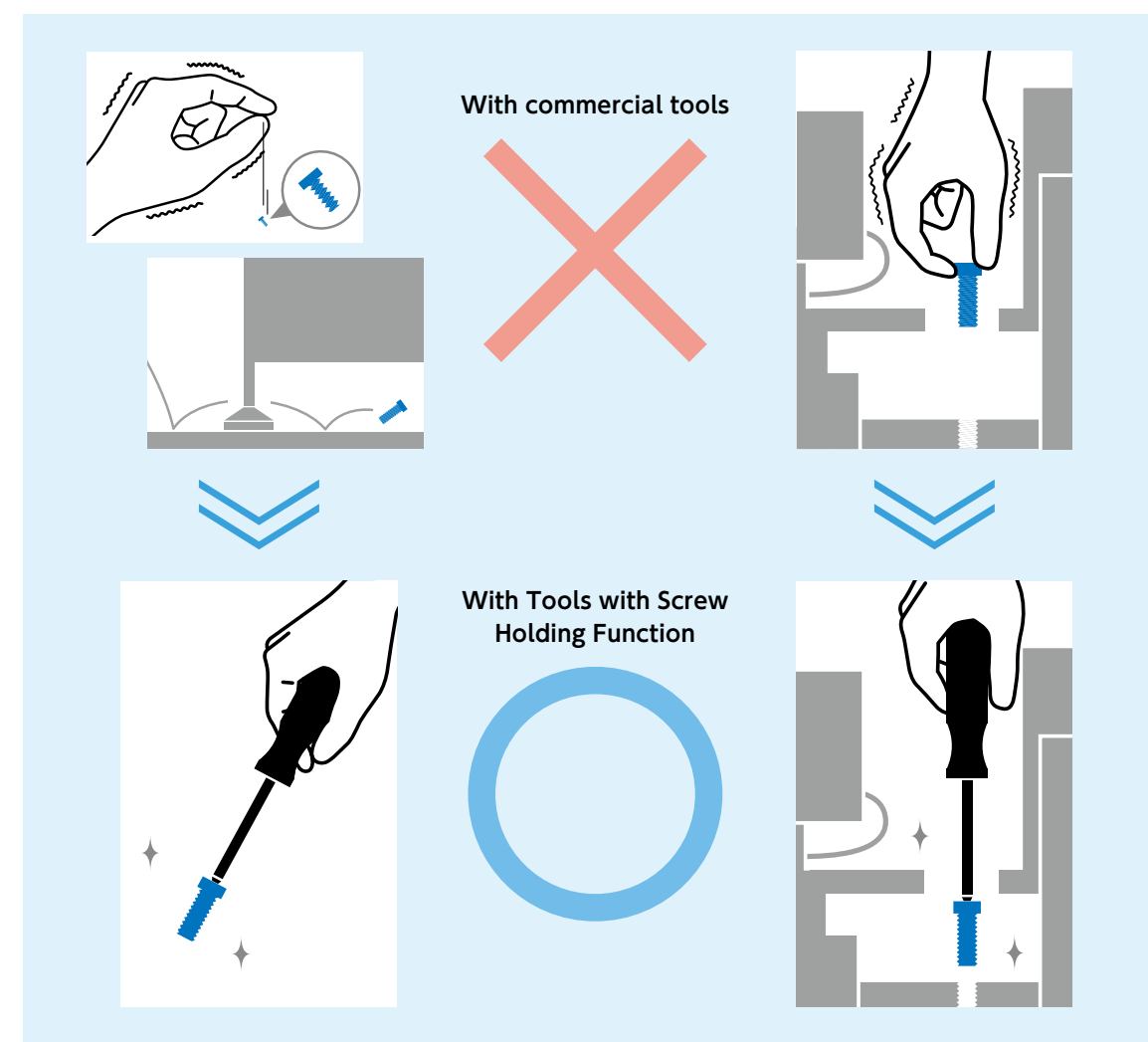


Captive screws and washers are also available



NBK offers products preventing screw/washer fall-out

These hexagon screwdrivers and hexagon sockets can retain screws at the tool tip. Screw mounting and removing is easy even with fiddly miniature screws and screws in inaccessible inner areas.



05 Increasing throughput

As worldwide demand for semiconductors increases, manufacturing equipment is called on for higher throughput.

Increasing throughput

One way to achieve this is to reduce wafer processing time, while another is to increase the production amount by space. Downsizing equipment means that each device requires

less installation space, enabling more semiconductors to be produced within the same plant size. Reducing maintenance time also helps extend production time.

Products with higher strength than ordinary screws are available

Smaller screw diameters and reduced quantities save space.

Commercial stainless steel screws

M6

Thickness **10mm**

Commercial stainless steel screws

High-Strength Stainless Steel Screws

M4

Smaller, with the same tightening force

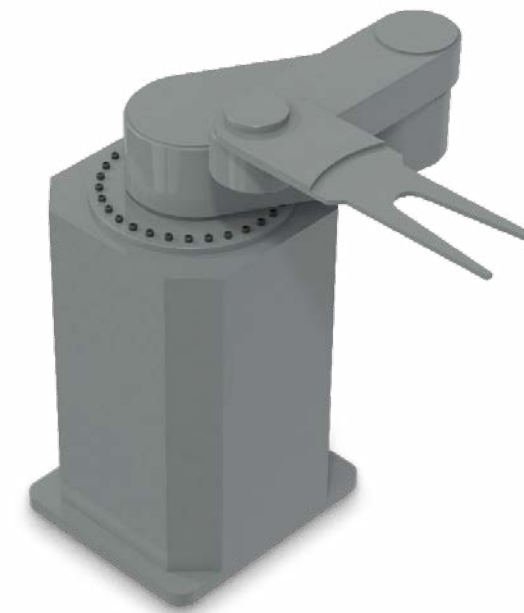
Thickness **7.5mm**

High-Strength Stainless Steel Screws

The screw tightening part is thinner, enabling **smaller sizes and lighter weight.**

► **High Strength SUS**
Vacuum Screws
SVSQLG

► **64 Titanium**
High-Strength Titanium Screws
SNSTG



NBK offers products that help increase throughput

Couplings that suppress vibration are available. Contributes to wafer conveying speed increase.

► **High-Gain**
Rubber Couplings
XG2

The abundant lineup of miniature and small-diameter screws under M2.5 contributes to equipment downsizing.

► **Miniature Screws**
For Precision Instruments
SNSS

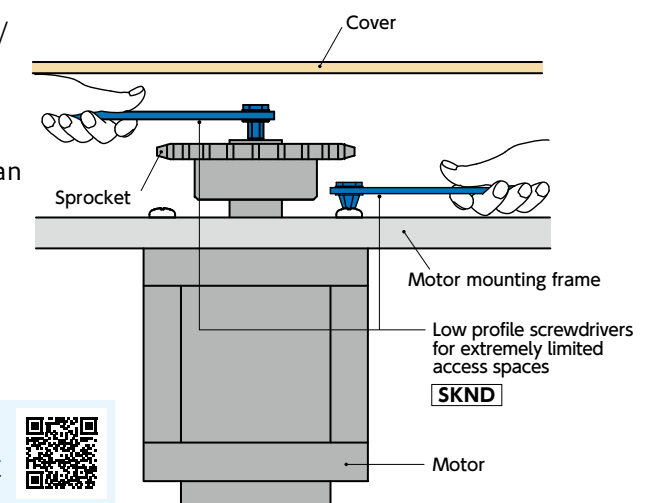
► **Miniature Screws**
Flat Head Machine Screws for Precision Instruments
SNZFS

► **Miniature Screws**
Pan Head Machine Screws for Precision Instruments
SNZS-S

Tools with reduced height dimensions are available

Usable in spaces where regular screwdrivers/wrenches cannot be used, they help reduce work hours for removing peripheral components, etc. Required working space is decreased, so device/equipment structure can also be made more compact.

► **For Extremely Limited Access Spaces**
Low Profile Screwdriver
SKND

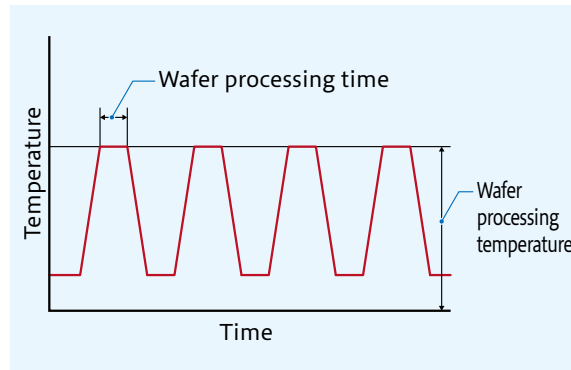


06 Thermal cycling

Thermal cycling is often an issue in semiconductor manufacturing equipment.

What is thermal cycling?

Depending on the specific equipment, the interior of semiconductor manufacturing equipment, such as ion generators in ion implantation equipment or light sources in lithography, may reach high temperatures of 500°C to 1000°C. As well, coating and etching equipment may also reach temperatures of 200°C to 400°C when processing wafers. The repeated shifts between normal and high temperature in equipment of this kind are called thermal cycling.



NBK offers screws which can be used to handle high-temperature environments and thermal cycling

Screws withstanding high-temperature environments are available.

[Full lineup of heat-resistant screws here ▶](#)



▶ Inconel 600 equivalent

Special Material Screws
SNSI



▶ Molybdenum

Special Material Screws
SNSM



▶ Tantalum

Special Material Screws
SNSTA



* Inconel is a registered trademark of Special Metals Corporation.

Screws resistant to galling and seizing in thermal-cycling environments are available.

[Full lineup of seizing-prevention screws here ▶](#)



▶ Surface Hardening Treatment

Special Surface Treated Screws
SNSL-PN



▶ Gold coating

Special Surface Treated Screws
SNSS-AUS



▶ PTFE Coating

Special Surface Treated Screws
SNSS-TF



Selection
Navigator



CAD Data
Download

<https://www.nbk1560.com/>

05

Solving complex problems using engineering capabilities Examples of Special Solutions

Introducing examples of special solutions
for various complex problems, based on flexible engineering capabilities.

- 01 Screws are needed to **retain strength even at 600°C high temperatures** 39
- 02 Screws **corrode** when exposed to hydrochloric acid 40
- 03 **Special Low Profile Cap Screws seize** in clean environments 41
- 04 **Miniature Screws** need **high heat resistance** 42
- 05 Using **corrosion-resistant ceramic screws** in a vacuum environment 43
- 06 Prevent **wafer transport robot screws** from **corroding** 44
- 07 The washers used with screws **fall during maintenance** 45
- 08 **Special examples of vacuum screws**
(Full Thread/Plastic/Captive/Miniature/Surface Treated) ... 46

Q: 01

Screws are needed to retain strength even at 600°C high temperatures

600°C

Decreased strength/
risks of damage
in oxidation/diffusion
equipment, etc.



Inconel 718 equivalent screws can be
manufactured with age-hardening heat treatment



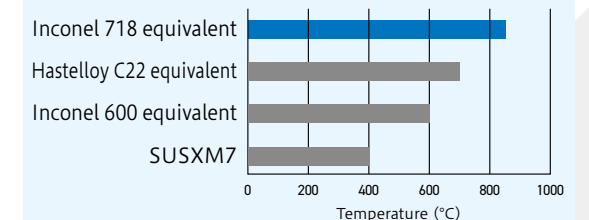
About Inconel 718

Inconel is a Ni-Cr-Fe type corrosion and heat resistant super-alloy. It is also specified by various standards such as JIS and ASTM, and is divided into 600, 625, 718 and the like depending on the added element. In particular, Inconel 718 is an alloy in which Mo, Nb, Ta and the like are added to Ni-Cr-Fe, providing high strength under high temperature environments and making it possible to achieve tensile strength up to approx. 800°C with age-hardening heat treatment. It is also called ALLOY718.

* Inconel is a registered trademark of Special Metals Corporation.

Characteristics

- ▶ Demonstrates high strength in the temperature range up to 800°C.
- ▶ Excellent high-temperature oxidation resistance.
- ▶ Age hardening heat treatment provides tensile strength of 1,280 MPa or higher.

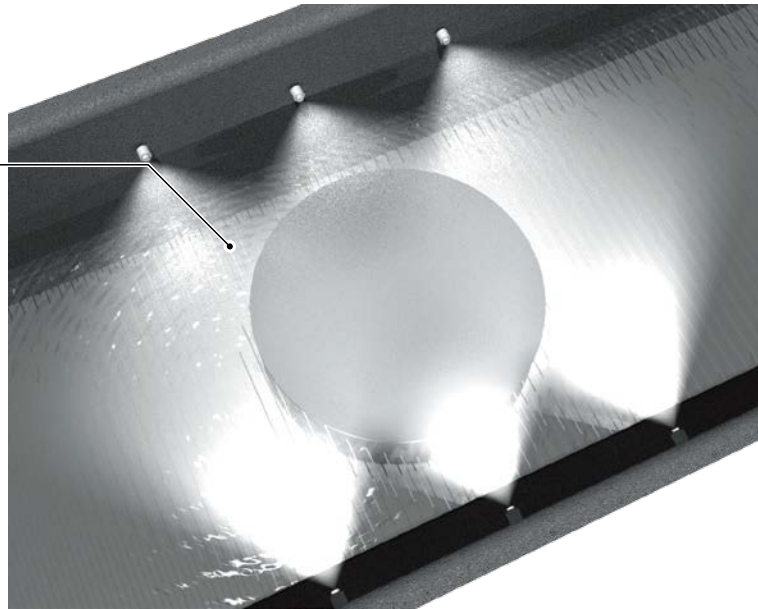


Q: 02

Screws corrode when exposed to hydrochloric acid

HCl

Corrosion/contamination risks in wafer cleaning machinery/cleaning process



Hastelloy B2 equivalent screws can be manufactured



About Hastelloy B2

Hastelloy is a Ni type corrosion resistant alloy that is a registered trademark of Haynes International, Inc. It is also specified by various standards such as JIS and ASTM, and is divided into Hastelloy B, Hastelloy C and the like depending on the added element. Hastelloy B2 is an alloy made up of Mo and others, and is a Ni-Mo type corrosion resistant alloy for hydrochloric acid.

* Hastelloy is a registered trademark of Haynes International, Inc.

Chemical Components

Hastelloy B2	UNS N10665	Al	B	C	Co	Cr	Cu	Fe	Mn	Mo	Ni	P	S	Si	Ti	W	Others
		-	-	0.02	1	1	-	2	1	26.0 30.0	Remainder	0.04	0.03	0.1	-	-	-

Characteristics

- ▶ High corrosion resistance to hydrochloric acid in a wide range of concentrations and temperatures.
- ▶ High corrosion resistance to sulfuric acid, phosphoric acid, hydrofluoric acid and acetic acid as well.

Q: 03

Special Low Profile Cap Screws seize in clean environments

Clean environments

Seizing/contamination risks in coater/developer / film formation process



Special Low Profile Cap Screws can be given surface hardening treatment

▶ SUS316L

Special Low Profile Hex Socket Head Cap Screws
SSH Series + Surface Hardening Treatment



What is Surface Hardening Treatment?

- ▶ Non-lubricated, yet does not cause seizing
- ▶ Axial force stabilization
- ▶ Can be used in high-temperature environments
- ▶ Replacement of currently used products is possible

Other Surface Hardening Treatments

In addition to the above, surface hardening treatment is available for SUS316L screws.



Q: 04

Miniature Screws need high heat resistance

1,000°C

Decreased strength/
risks of damage
in lithography light
sources, etc.



Miniature Screws can be manufactured
from pure molybdenum

► Molybdenum

Special Material Screws
SNSM



■ Characteristics of Pure Molybdenum

Melting point: 2623°C. Excellent heat resistance.

M2 and other sizes not available as standard products can also be manufactured.

■ Physical Properties

	Pure Molybdenum	SUS304
Specific Gravity	10.2	7.93
Longitudinal Elastic Modulus (GPa)	327	193
Electric Resistance ($\mu\Omega \cdot m$)	0.058	0.7
Thermal Conductivity (W/(m · K))	142	17
Linear Expansion Coefficient (K ⁻¹)	5.1×10^{-6}	17.3×10^{-6}

* Values in chart are for reference only. They are not guaranteed values.

■ Mechanical Properties

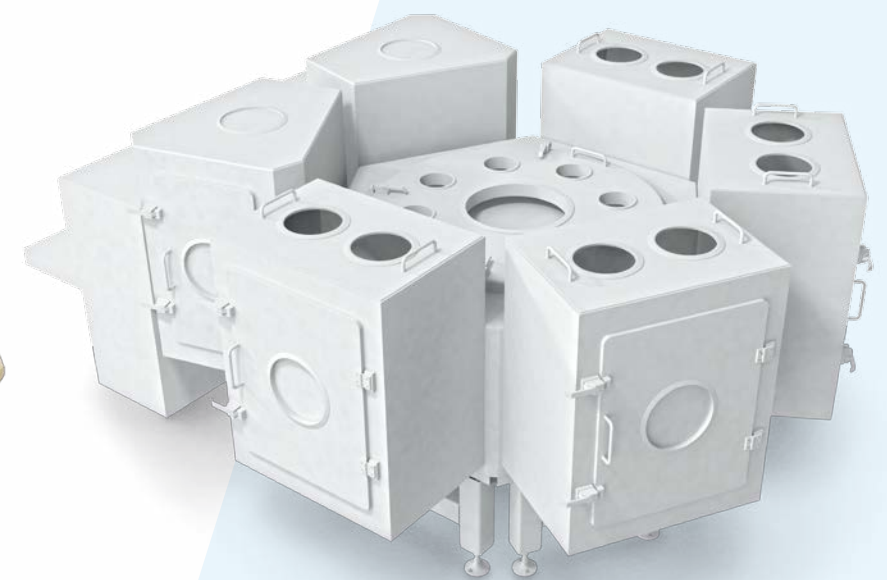
	Pure Molybdenum	SUS304
Tensile Strength (N/mm ²)	515	520 or More
0.2% Proof Load (N/mm ²)	380	205 or More
Elongation (%)	15	40 or More

* Values in chart are for reference only. They are not guaranteed values.

Q: 05

Using corrosion-resistant ceramic screws in a vacuum environment

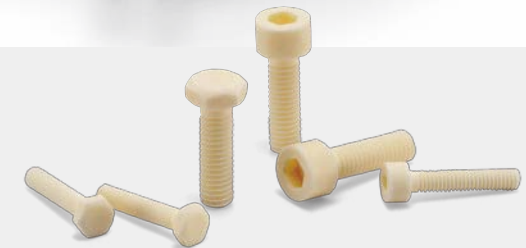
Ventilation hole



We provide degassing holes for vacuum
equipment on ceramic cap screws

► Ceramic

Special Material Screws
SCX + Ventilation Hole Processing



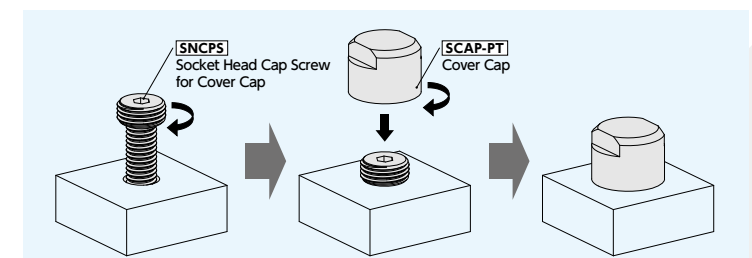
Degassing holes for vacuum equipment can be machined even on ceramic screws. Degassing holes support evacuation. This is recommended for environments where plasma gas is present and corrosion resistance is required. Cleanroom washing and cleanroom packing can be performed. Both socket head cap screws for cover caps and cover caps

can be specially machined to have degassing holes for vacuum equipment. Socket head cap screws for cover caps and cover caps can also be manufactured with materials such as Hastelloy and Inconel.

* Hastelloy is a registered trademark of Haynes International, Inc.
* Inconel is a registered trademark of Special Metals Corporation.

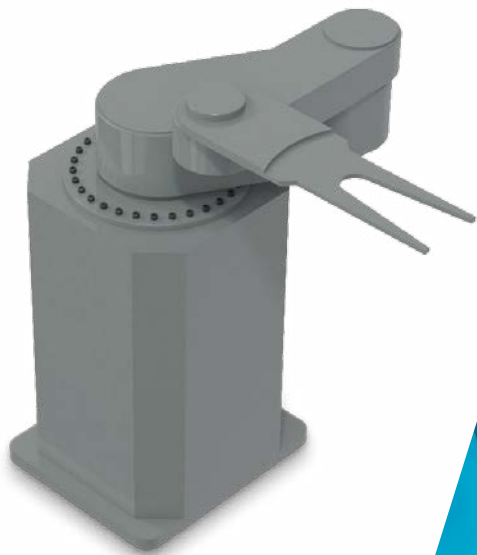
■ Bolt Protection with Ceramic Ball Tips

Cap screws can be protected by attaching a ceramic cap to a stainless steel screw. As the tightening part of the screw is made of stainless steel, a higher tightening force is obtained compared to aluminum and ceramic screws.



Q: 06

Prevent wafer transport robot screws from corroding



Replacement of screws in use with materials such as titanium, Hastelloy, or Inconel

► Titanium

Low Profile/Small Head Screws
SSHT



Screws made from materials such as titanium, Hastelloy, and Inconel can be manufactured with the same shape as the screws currently being used. Low profile and special low profile cap screws are often used in wafer transport robots. Shapes not

available as standard products can also be manufactured.

* Hastelloy is a registered trademark of Haynes International, Inc.
* Inconel is a registered trademark of Special Metals Corporation.



► **Hastelloy C-22**
Special Material Screws
SNSH-C22



► **Inconel 600 equivalent**
Special Material Screws
SNSI



Q: 07

The washers used with screws fall during maintenance

Captive

Contamination risks throughout equipment and processes



Screws with integrated washers made from Inconel and Hastelloy can be manufactured

► Hastelloy C-22

Special Material Screws
SNSH-C22



■ Fall-out Prevention with Special Materials

Screws with integrated washers made from special materials including Inconel and Hastelloy can be manufactured. If the screw and washer are separate, the washer could fall into the equipment during assembly or maintenance. A screw with integrated washer (where the washer is assembled into the screw during thread rolling) will prevent the washer from dropping down. This helps to improve work efficiency.

* Inconel is a registered trademark of Special Metals Corporation.
* Hastelloy is a registered trademark of Haynes International, Inc.



► **Inconel 600 equivalent**
Special Material Screws
SNSI



► **With Built-in Washer**
High Strength SUS
SNSQLG



Q: 08

Special examples of vacuum screws (Full Thread/Plastic/Captive/Miniature/Surface Treated)



■ Surface treatment can be provided on the screws for vacuum equipment

Standard products are also available in a lineup with a surface treatment that prevents galling, but other surface treatments can also be provided.

► **Special Surface
Hardening
Treatment**



► **Screws for
Vacuum
Equipment**



■ Miniature Screws and Full Thread Screws can be machined to have degassing holes for vacuum equipment

Miniature screws such as M1.6 can be machined to have degassing holes for vacuum equipment. Screws with a long thread part can be machined to have degassing holes for vacuum equipment.

► **Miniature
Screws**

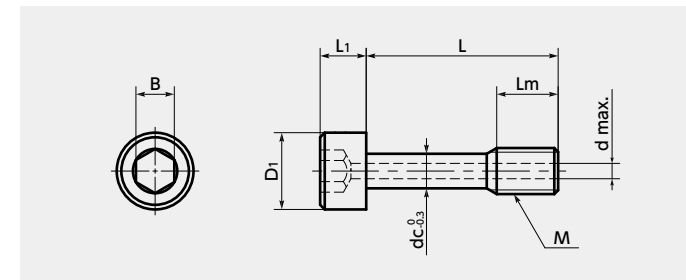


► **Full Thread**



■ Captive screws can be machined to have degassing holes for vacuum equipment

For captive screws, the dimensional difference between d_c and d in the figure below is smaller and the strength is reduced, so the degassing holes should be smaller than normal holes.



► **Captive Screws**



■ Plastic screws such as VESPEL can be machined to have degassing holes for vacuum equipment

Plastic screws can be used in environments where metal corrodes, etc.

► **Plastic Screws**



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