

SAFETY DATA SHEET

PRODUCT NAME: CBN (Cubic Boron Nitride) Tools

1. Identification of the Substance and of the Company

1-1. Product Identifier : CBN (Cubic boron nitride) and Cemented Carbide base metal
(hereinafter referred to "CBN/Cemented Carbide")

1-2. Company Information

Manufacturer : Kyocera Corporation

Address : 6 Takeda Tobadono-Cho, Fushimi-Ku Kyoto 612-8501

Division : Corporate Cutting Tool Group

Phone No. : +81-75-604-3651 FAX No. : +81-75-604-3472

Emergency Contact : Sendai Quality Assurance Section (Sendai Plant) Phone No. : +81-996-23-4116

1-3. Recommended use and Restriction on use :

Cutting tools for mainly metal materials, wear-resistant tools for plastic forming process, etc..

1-4. Attention to the Phase/State of the CBN/Cemented Carbide

- CBN/Cemented Carbide as solid state like cutting tools is chemically stable and safe at explosive, flammable, combustible, pyrophoric, water-reactive, and oxidizability under normal environment.
- CBN/Cemented Carbide are safe for use as the cutting tools (grinding, machining, rolling for metals) under normal condition.
- This SDS informs about the dust, fume or vapor which occur from CBN/Cemented Carbide producing process such as raw material powder handling and grinding.

2. Hazards Identification

2-1. GHS classification

Some data (such as the burning rate test data, etc.) for the dust, fume or vapor which occur from CBN/Cemented Carbide producing process are unavailable. Therefore, they are not be classified by GHS.

In here, GHS classification of the each metallic ingredient (cobalt, nickel and chromium) for composing the CBN/Cemented Carbide can be disclosed. In addition, other hazards and harmful effects (for health, environment, physical and chemical) which are not listed are unclassifiable or non-applicable by GHS.

GHS classification for the hazards of cobalt alone in below,
(When cobalt is included as ingredients of CBN/Cemented Carbide.)

Health Hazard	<ul style="list-style-type: none"> • Respiratory sensitization • Skin sensitization • Carcinogenicity • Reproductive toxicity • Specific target organ toxicity (Single exposure) • Specific target organ toxicity (Repeated exposure) 	Category1 Category1 Category2 Category2 Category3 (Respiratory tract irritation) Category1 (Respiratory)
Environmental Hazard:	<ul style="list-style-type: none"> • Hazardous to the aquatic environment 	Category4

GHS classification for the hazards of nickel alone in below,
(When nickel is included as ingredients of CBN/Cemented Carbide.)

Health Hazard	<ul style="list-style-type: none"> • Respiratory sensitization • Skin sensitization • Carcinogenicity • Specific target organ toxicity (Single exposure) 	Category1 Category1 Category2 Category1 (Respiratory tract irritation)
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	<ul style="list-style-type: none"> • Specific target organ toxicity (Repeated exposure) 	Category1 (Respiratory)
Environmental Hazard:	<ul style="list-style-type: none"> • Hazardous to the aquatic environment 	Category4

GHS classification for the hazards of chromium alone in below,
(When chromium is included as ingredients of CBN/Cemented Carbide.)

Health Hazard	<ul style="list-style-type: none"> • Serious eye damage • Respiratory sensitization • Skin sensitization • Germ cell mutagenicity • Specific target organ toxicity (Single exposure) • Specific target organ toxicity (Repeated exposure) 	Category2B Category1 Category1 Category2 Category2 (Respiratory tract irritation) Category3 (Respiratory)
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2-2. GHS Label Elements

GHS label elements of the each metallic ingredients (cobalt, nickel and chromium) for composing the CBN/Cemented Carbide can be disclosed in below.

	Cobalt	Nickel	Chromium
Hazard Pictograms :			
Signal Words :	Danger		
Hazard Statements :	<ul style="list-style-type: none"> • Risk of causing allergies, asthma or breathing difficulties if inhaled. • Risk of causing an allergic skin reaction. • May cause cancer. • May cause adverse effects on fertility or the unborn child. • Risk of respiratory irritation. • Cause of respiratory failure due to long-term or repetitive exposure. • May be harmful to aquatic life due to long-term effects 	<ul style="list-style-type: none"> • Risk of causing allergies, asthma or breathing difficulties if inhaled. • Risk of causing an allergic skin reaction. • May cause cancer. • Respiratory and kidney disorders • Cause of respiratory failure due to long-term or repetitive exposure. • May be harmful to aquatic life due to long-term effects 	<ul style="list-style-type: none"> • Risk of causing allergies, asthma or breathing difficulties if inhaled. • Risk of causing an allergic skin reaction. • Suspected of causing genetic disease • Failure to systemic toxicity • Risk of respiratory irritation.
Precautionary Statements :	【Prevention】 <ul style="list-style-type: none"> • Obtain safety instructions* before use. • Do not handle until all safety precautions have been read and understood. • Use appropriate personal protection and ventilation system keeping away from exposure. • Wear suitable protective gloves. • When insufficient ventilation, wear respirator as required. • Do not breathe dust, fume or vapor. • Do not eat, drink or smoke in handling area. • Wash skin thoroughly after handling. • Do not release into the environment. 		

【Responses】

- If inhaled, move to fresh air and take a rest with posture easy to breathe.
- If respiratory symptoms occurs, contact a doctor.
- When feeling ill, get medical advice/attention.
- Take off contaminated clothing and wash before reuse.
- If on skin, rinse away immediately with a large amount of water and soap.
- If skin irritation occurs, contact a doctor and get medical advice/attention.
- If exposed or concerned, get medical advice/attention.
- If dust is in eyes, immediately wash away with clean water (remove the contact lenses if possible). If irritation persists, get medical advice/attention.
- If a large amount of dust is swallowed, get medical advice/attention after ingesting plenty of water to dilute.

【Storage】

- Avoid sudden changes of temperature and high humidity for storage.

【Disposal】

- Dispose of contents/container to an approved waste disposal plant under the laws.

*For safety instructions, refer to the Japan Cutting & Wear-resistant Tool Association website (<http://www.jta-tool.jp/>) .

3. Composition/Information on Ingredients

- Distinction between substance and mixture: Mixture (alloy)
- Chemical name or generic name : Cubic boron nitride and Cemented carbide
- CBN may be coated with the following materials:
TiN, (Al,Ti,M)N : M represents one or more metal elements selected from the group consisting of Si, Cr, Mo, W and Nb.
- Ingredients and concentration or concentration range (composition) of the CBN/Cemented Carbide.

Ingredient	Chemical Formula	CAS#	Official Number ,Law for PRTR*	Industrial Safety and Health Law(Official Number)	Composition mass%
CBN layer + Cemented Carbide layer					
Boron Nitride	BN	10043-11-5	Class 1:405	N/A	25--95
Aluminum Nitride	AlN	24304-00-5	N/A	N/A	1--20
Titanium Carbonitride	TiCN	N/A	N/A	N/A	1--20
Aluminum Diboride	AlB ₂	12041-50-8	Class 1:405	N/A	0--20
Aluminum Oxide	Al ₂ O ₃	1344-28-1	N/A	Appendix 9-189	1-- 5
Titanium Diboride	TiB ₂	12045-63-5	Class 1:405	N/A	1--10
Titanium Carbide	TiC	12070-08-05	N/A	N/A	1--20
Tungsten Boride	WB	12007-09-9	Class 1:405	N/A	0-- 5
Titanium Aluminide	TiAl	12004-78-3	N/A	N/A	0-- 2
Tungsten Carbide	WC	12070-12-1	N/A	N/A	0--50
Cobalt	Co	7440-48-4	Class 1:156	Appendix 9-172	5--15
Junction layer					
Silver	Ag	7440-22-4	Class 1: 82	Appendix 9-137	0--80
Copper	Cu	7440-50-8	N/A	Appendix 9-379	20--60
Nickel	Ni	7440-02-0	Class 1: 354	Appendix 9-418	0--10
Cemented Carbide(Base Insert)					
Tungsten Carbide	WC	12070-12-1	N/A	N/A	85--95
Cobalt	Co	7440-48-4	Class 1:156	Appendix 9-172	5--15
Titanium Carbide	TiC	12070-08-05	N/A	N/A	0--10
Vanadium carbide	VC	12070-10-9	Class1:363	N/A	0--5
Chromium	Cr	7440-47-3	Class 1: 111	Appendix 9-142	0--5
Nickel	Ni	7440-02-0	Class1:354	Appendix9-418	0--5

*Law for PRTR : Law concerning Reporting, etc. of Releases to the Environment of Specific Chemical Substances and Promoting Improvements in Their Management.

- For the details regarding the content of the designated chemical material such as cobalt, nickel, and chromium, boron nitride, aluminum diboride, titanium diboride, tungsten boride, and vanadium carbide (effective digit: 2), please contact the

above address.

- Even if the cemented carbide do not contain cobalt, nickel, chromium as an active ingredient may include cobalt, nickel, chromium as an impurity.

4. First-Aid Measures

Inhalation:

- If the high concentration of dust is inhaled or respiratory symptoms (coughs, gasping, shortness of breath, etc.) are experienced, move to fresh air and take a rest with posture easy to breathe. If breathing difficulties occur, administer oxygen inhalation. If breathing has stopped, immediately administer artificial respiration and get medical advice/attention.
- If irritation or rash persists, get medical advice and attention.

Skin Contact:

- If dust is contacted with skin, take off contaminated clothing and rinse the affected area with soapy water thoroughly.
- If irritation or rash persists, get medical advice/attention.

Eye Contact

- If dust is in eyes, immediately wash away with clean water (remove the contact lenses if possible).
- If irritation persists, get medical advice/attention.

Ingestion

- If a large amount of dust is swallowed, get medical advice/attention after ingesting plenty of water to dilute.

5. Fire-Fighting Measures

Extinguishing Media

- To extinguish the fire of dust, use dry sand, expanded vermiculite, dilatable perlite, ABC type (general, oil, electric fire) powder extinguishers or water (no water allowed for the dust containing cut powders of light metal such as magnesium and aluminum).

Special Protective Actions for Fire-Fighters

- In fighting a fire, wear a protective clothing, dust-proof respirator or respiratory protective equipment

6. Accidental Release Measures

Personal Precautions, Protective Equipment

- It is recommended that someone who cleans dust should wear clothing and respiratory protective equipment to minimize exposure.

Environmental Precautions

- Dispose of dust as industrial wastes and prevent release in water systems.

Containment and Cleanup Methods and Equipment

- If there is dust which occur from Cemented Carbide producing process, isolate the area and remove with a cleaner equipped with a filter which can take up fine particles very efficiently. If appropriate removing methods are not available, sweep with water sprayers or wet mops.

7. Handling and Storage

Handling:

- If the disperse of dust containing cobalt or nickel is concerned, provide local exhaust ventilation and use personal protective equipment to minimize exposure to human body.
- Obtain safety instructions before use.
- Do not handle until all safety precautions have been read and understood.
- Do not breathe dust, fume or vapor.
- Do not eat, drink or smoke in handling area.
- Wash skin thoroughly after handling.
- Do not release into the environment.
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Storage:

- Avoid sudden changes of temperature and high humidity for storage.
- Materials suitable for the specific gravity of cemented carbide should be used for containers and packaging.

8. Exposure Controls/Personal Protection**Exposure Prevention**

- Permissible concentration in working environment (reference value)

Ingredient	Chemical Formula	OSHA*PEL* mg/m ³ (Metal dust concentration)	ACGIH*TLV* mg/m ³ (Metal dust concentration)	JSOH*OEL* mg/m ³ (Respirable dust conc.)
CBN layer and Cemented Carbide layer				
Boron Nitride	BN	10	10	N/A
Cobalt	Co	0.1	0.02	0.05
Aluminum Nitride	AlN	N/A	N/A	N/A
Aluminum Diboride	AlB ₂	N/A	N/A	N/A
Aluminum Oxide	Al ₂ O ₃	5	10	N/A
Titanium Diboride	TiB ₂	N/A	N/A	N/A
Titanium Carbide	TiC	N/A	N/A	N/A
Titanium Carbonitride	TiCN	N/A	N/A	N/A
Tungsten Boride	WB	N/A	5 (as W)	N/A
Titanium nitride	TiN	N/A	N/A	N/A
Titanium Aluminide	TiAl	N/A	N/A	N/A
Tungsten Carbide	WC	N/A	5 (as W)	N/A
Vanadium carbide	VC	N/A	N/A	N/A
Nickel	Ni	1	1.5	1.0
Chromium	Cr	1	0.5	0.5

* OSHA: Occupational Safety & Health Administration U.S. Department of Labor

* PEL: Permissible Exposure Limit

* ACGIH: American Conference of Governmental Industrial Hygienists Inc.

* TLV: Threshold Limit Value

* JSOH: Japan Society for Occupational Health

* OEL: Occupational Exposure Limit

* N/A: Not Applicable

Facility measures

Provide local exhaust ventilation so that dusts in the air may not exceed the exposure limits in the above table. It is to be noted that management concentration of the cobalt (and its inorganic compounds) is to be 0.02mg/m³ in accordance with the working environment assessment standard by Japanese Minister of Health, Labour and Welfare under the paragraph (2), Article 65-2 of the Industrial Safety and Health Act in Japan.

In addition, cobalt (and its inorganic compounds) in the storage or handling, and that to take the necessary action conforming to the Ordinance on Prevention of Hazards due to Specified Chemical Substances.

Protection equipment

- Respiratory Protection: Dust-proof respirators and respiratory protective equipment are recommended.
- Hand Protection: Protective gloves for dust are recommended.
- Eye Protection: Protective glasses for dust are recommended.
- Skin/Body Protection: Avoid direct skin contact with dust.
Clean up deposited dust on clothing, rags, etc. by washing or absorbing with suitable Filters but not by whisking off. Change the contaminated clothing into clean one.

Hygiene Measure

Wash skin thoroughly after handling.

9. Physical and Chemical Properties

Physical state	Solid
Appearance:	Dark gray color (In case of the coated or surface treated cemented carbide, the appearance color is often different.)
Odor:	Odorless
Melting point:/Freezing point	No data available
Boiling point:	No data available
Combustibility	Incombustibility
Flash point:	No data available
Spontaneous ignition point	Not spontaneously ignited
pH:	No data available
Kinematic viscosity	No data available
Solubility:	Insoluble
Vapor pressure:	No data available
Specific gravity:	11.0 - 15.5
Relative gas density	No data available
Particle characteristic	No data available

10. Stability and Reactivity

A grain of dust which occur from CBN/Cemented Carbide producing process is very fine and under the specific conditions in which the dusts are mixed with grinding oil with low flash point, it is possible to become pyrophoric. If dusts under very flammable conditions are dispersed in the air, it is possible to explode.

The each metallic ingredients (cobalt, nickel and chromium) for composing the CBN/Cemented Carbide has the following information about stability and reactivity under specific conditions.

Stability and reactivity of cobalt alone in below,

(When cobalt is included as ingredients of CBN/Cemented Carbide.)

Reactivity, Chemical stability:	Stable to heat and contact with water
	Ignite spontaneously in air
Hazardous reactions:	It reacts with strong oxidizing agents
	It reacts violently with oxygen, and it poses a risk of fire or explosion
	It reacts violently with acid to generate hydrogen
Conditions to avoid:	Contact with incompatible materials
Incompatible and dangerous materials:	Strong oxidizing agents, acid
Hazardous decomposition products:	By combustion, cobalt oxide and fumes of cobalt oxide may occur

Stability and reactivity of nickel alone in below,

(When nickel is included as ingredients of CBN/Cemented Carbide.)

Reactivity, Chemical stability:	It is considered stable in storage and handling in accordance with the laws and regulations
Hazardous reactions:	Metallic nickel is usually stabilized against oxidation by the oxide film, fresh metal surfaces without oxide film is rapidly oxidized by air. Thus, fresh metallic nickel powder, there is a risk of ignition in air.
Conditions to avoid:	No data available
Hazardous decomposition products:	No data available

Stability and reactivity of chromium alone in below,

(When chromium is included as ingredients of CBN/Cemented Carbide.)

Stability:	Stable under normal handling conditions
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Hazardous reactions:	Reacts violently with strong oxidizing agents such as hydrogen peroxide, it poses a risk of fire or explosion.
	It reacts with dilute hydrochloric acid and dilute sulfuric acid.
Conditions to avoid:	The alkali or alkaline carbonate is Incompatible.
	When mixed with air in powder or granular form, there is a possibility of dust explosion.
Incompatible hazardous materials:	Strong oxidizing agents, dilute hydrochloric acid, dilute sulfuric acid, alkali, alkali carbonate
Hazardous decomposition products:	During combustion, there can be irritating or toxic fumes and gases.

11. Toxicological Information

Acute Toxicity:	No data available on CBN/Cemented Carbide
Skin Corrosion/Irritation:	No data available on CBN/Cemented Carbide
Serious Eye Damage/Eye Irritation:	No data available on CBN/Cemented Carbide
Respiratory or Skin Sensitization:	No data available on CBN/Cemented Carbide
Germ Cell Mutagenicity:	No data available on CBN/Cemented Carbide
Carcinogenicity:	Group 2A on IARC, as cobalt powder coexisting with tungsten carbide powder. Suspected to be carcinogenic in humans (Ref.1)
Reproductive Toxicity:	No data available on CBN/Cemented Carbide
Specific Target Organ Toxicity/Systemic Toxicity: (Single Exposure)	No data available on CBN/Cemented Carbide
Specific Target Organ Toxicity/Systemic Toxicity: (Repeated Exposure)	No data available on CBN/Cemented Carbide
Aspiration Hazard:	No data available on CBN/Cemented Carbide

12. Ecological Information

The aquatic environment acute hazard

- Not reported on CBN/Cemented Carbide

The aquatic environment chronic hazard

- Not reported on CBN/Cemented Carbide

Mobility

- Not reported on CBN/Cemented Carbide

13. Disposal Considerations

Information on safe and environmentally preferable disposal or recycling

- The main ingredients such as tungsten carbide, cobalt, nickel are rare metal. It is desirable to collect and recycle them.
- For disposal, conform to the applicable laws regarding industrial wastes such as 'Waste Disposal and Public Cleansing Law' and relevant local by laws.

14. Transport Information

International Regulations

UN Number:	Not applicable
UN Hazard Class:	Not applicable
Marine Pollutant:	Not applicable

*When transporting a powder of metallic ingredients (cobalt, nickel) for composing the CBN/Cemented Carbide, there is a possibility that it is necessary to take appropriate action in accordance with the relevant provisions established by IMO (International Maritime Organization), ICAO (International Civil Aviation Organization), IATA (International Air Transport Association).

Domestic Regulations

Land Regulatory Information	Not applicable
UN Number:	Not applicable
UN Hazard Class:	Not applicable

Marine Pollutant: Not applicable

*When transporting a powder of metallic ingredients (cobalt, nickel) for composing the CBN/Cemented Carbide, there is a possibility that it is necessary to take appropriate action in accordance with the relevant provisions of Ship Safety Law and the Aviation Law.

Special Safety Measures

When transporting the dust which occur from CBN/Cemented Carbide producing process, make sure that there is no damage or corrosion or leakage of the container, to ensure implementation of the prevention of collapse of cargo.

15. Regulatory Information

• Law for Pollutant Release and Transfer Register (PRTR)

Boron nitride	:	"Class 1 designated chemical substances", Cabinet Order No.405
Cobalt	:	"Class 1 designated chemical substances", Cabinet Order No.132
Aluminum diboride	:	"Class 1 designated chemical substances", Cabinet Order No.405
Titanium diboride	:	"Class 1 designated chemical substances", Cabinet Order No.405
Tungsten boride	:	"Class 1 designated chemical substances", Cabinet Order No.405
Vanadium carbide	:	"Class 1 designated chemical substances", Cabinet Order No.321
Nickel	:	"Class 1 designated chemical substances", Cabinet Order No.308
Chromium	:	"Class 1 designated chemical substances", Cabinet Order No.87

• Industrial Safety and Health Law, Ordinance on Prevention of Hazards due to Specified Chemical Substances

Cobalt: The substances are defined in the Article 57-2 of the Act, and the cobalt is listed by No.172 in Appended Table9 in the Article 18-2 of the Enforcement Order as "Dangerous or Harmful Substances to be notified their names, etc. Article 2, Paragraph 1, Items 2 and 5 of Ordinance on Prevention of Hazards due to Specified Chemical Substance, Specified chemical substance class 2, Management class 2.

When the content of cobalt and cobalt oxide is less than 1%, the Ordinance on Prevention of Hazards due to Specified Chemical Substance is not covered.

Aluminum oxide: The substances are defined in the Article 57-2 of the Act, and the aluminum oxide is listed by No.189 in Appended Table9 in the Article 18-2 of the Enforcement Order as "Dangerous or Harmful Substances to be notified their names, etc."

Nickel: The substances are defined in the Article 57-2 of the Act, and the nickel is listed by No.418 in Appended Table9 in the Article 18-2 of the Enforcement Order as "Dangerous or Harmful Substances to be notified their names, etc."

Chromium: The substances are defined in the Article 57-2 of the Act, and the chromium is listed by No.142 in Appended Table9 in the Article 18-2 of the Enforcement Order as "Dangerous or Harmful Substances to be notified their names, etc."

• Water pollution prevention law

Boron nitride: Article 2, Paragraph 2, Item 1 of the Act, Enforcement Order Article 2 Hazardous Substance No. 24

Aluminum diboride: Article 2, Paragraph 2, Item 1 of the Act, Enforcement Order Article 2 Hazardous Substance No. 24

Titanium diboride: Article 2, Paragraph 2, Item 1 of the Act, Enforcement Order Article 2 Hazardous Substance No. 24

Tungsten boride: Article 2, Paragraph 2, Item 1 of the Act, Enforcement Order Article 2 Hazardous Substance No. 24

• Soil Contamination Countermeasures Act

Boron nitride: Article 2, Paragraph 1 of the Act, Enforcement Order Article 1 Specified Hazardous Substance No. 23

Aluminum diboride: Article 2, Paragraph 1 of the Act, Enforcement Order Article 1 Specified Hazardous Substance No. 23

Titanium diboride: Article 2, Paragraph 1 of the Act, Enforcement Order Article 1 Specified Hazardous Substance No. 23

Tungsten boride: Article 2, Paragraph 1 of the Act, Enforcement Order Article 1 Specified Hazardous Substance No. 23

In other region, follow the local regulations.

16. Other Information

Other Hazardous Information

The following attention should be paid for dust which occur from CBN/Cemented Carbide producing process.

- If a large amount of dust containing cobalt is inhaled, blood, heart, thyroid gland, and spleen disorders may result. (Ref.2)
- It is reported that repeated or prolonged contact with cobalt, nickel, or chromium may affect skin, respiratory organs, heart, etc. (Ref.3 - 6)
- Inhaling high concentration dust of aluminum oxide may irritate the eyes and upper respiratory tract. (Ref.4)
- Repeated or prolonged inhalation and exposure of aluminum oxide may cause effects on the central nervous system. (Ref.4)
- For carcinogenicity of metallic ingredients of CBN/Cemented Carbide has the following knowledge.

Cobalt metal	ACGIH	A3: Confirmed animal carcinogen with unknown relevance to humans.
	IARC	2B: Possibly carcinogenic to humans.
	Japan Society for Occupational Health	2B: The substance has been determined to be possibly carcinogenic to humans (with relatively insufficient evidence).
Nickel metal	ACGIH	A5: Not suspected as a human carcinogen.
	IARC	2B: Possibly carcinogenic to humans.
	Japan Society for Occupational Health	2B: The substance has been determined to be possibly carcinogenic to humans (with relatively insufficient evidence).
Chromium metal	IARC	3: Not classifiable as to its carcinogenicity to humans.

*ACGIH : American Conference of Governmental Industrial Hygienists Inc.

*IARC : International Agency for Research on Cancer

Disclaimer

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Numerical values, such as content, physics/chemical property, are not guaranteed values.

Reference URI

- Ministry of Economy, Trade and Industry : <http://www.meti.go.jp/>
- Ministry of the Environment : <http://www.env.go.jp/>
- Ministry of Health, Labour and Welfare : <http://www.mhlw.go.jp/>
- Japan Industrial Safety and Health Assoc. : <http://www.jaish.gr.jp/>
- International Agency for Research on Cancer : <http://monographs.iarc.fr/>
- International Chemical Safety Card : <http://www.nihs.go.jp/ICSC/>
- National Institute of Technology and Evaluation : <https://www.nite.go.jp/en/index.html>

References Documents

- (1) IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, vol.86 (2006).
- (2) Food & Drug Research Laboratories, study No.8005B (4.11.84).
- (3) Shirakawa et al., Chest. 95, 29 (1989).
- (4) International Chemical Safety Cards (cobalt, chromium, nickel).
- (5) The Guide to Chemical Hazards (edited by Japan Industrial Safety & Health Association)
- (6) A. O. Bech et al., Brit. J. Ind., 19, 239 (1962)