

# ANGSTROM SCIENCES, INC.

40 SOUTH LINDEN STREET, DUQUESNE, PA 15110 / PHONE: (412) 469-8466 FAX: (412) 469-8511

www.angstromsciences.com

## CERTIFICATE OF ANALYSIS

**COMPANY:** UNIVERSITY OF LOUISVILLE

**PO#:** CRAIN 2-21

**MATERIAL:** NICKEL 50% TITANIUM 50% AT%  
(Ni<sub>50</sub>Ti<sub>50</sub> at%)

**PURITY:** 99.95%

**DESCRIPTION:** SPUTTERING TARGET

**LOT#:** 07-16870NiTi

**NOTES:** ANALYSIS IN PPM

### NICKEL 99.99%

C	<30
Ag	<1
Cu	<5
Fe	<15
O	<40
Al	<4
As	<1
Mn	<2
B	<5
Bi	<0.2
Cd	<1
Co	<5
H	<8
N	<5
Pb	<1
S	<5
In	<1
Ca	<10
Si	<10
Sn	<1
Te	<0.5
Tl	<0.5
Zn	<5
Sb	<1
Ga	<1
Mg	<5
Mo	<5
Cr	<5
Na	<5
P	<2
Se	<1

### TITANIUM 99.995%

Al	0.55	Be	<0.005	Hf	<0.01
As	<0.01	B	0.0165	Ta	<5
C	11.5	F	<0.05	Re	<0.01
Cl	0.085	P	0.016	Os	<0.01
Co	0.019	Ca	<0.2	Ir	<0.01
Cr	0.6	Sc	<0.05	Pt	<0.05
Cu	0.3	Ti	Matrix	Au	<0.05
Fe	3.5	Ga	<0.05	Hg	<0.1
H	1	Ge	<0.05	Tl	<0.01
K	<0.01	Se	<0.05	Pb	<0.01
Li	<0.005	Br	<0.05	Bi	<0.01
Mg	<0.05	Rb	<5		
Mn	0.0375	Sr	<3000		
Mo	<0.05	Y	<200		
N	<10	Ru	<0.01		
Na	<0.01	Rh	<0.15		
Nb	<0.2	Pd	<0.01		
Ni	0.18	Ag	<0.05		
O	133	Cd	<0.005		
S	<5	In	<0.005		
Si	0.4	Sb	<0.005		
Sn	<0.05	Te	<0.05		
Th	<0.0005	I	<0.01		
U	<0.0005	Cs	<0.01		
V	0.13	Ba	<0.005		
W	<0.01	La	<0.005		
Zn	<0.05	Ce	<0.005		
Zr	0.6	Nd	<0.005		

**ATTESTOR:**

*Mark A. Bernick 10/6*

**MARK A. BERNICK, QUALITY ASSURANCE DIRECTOR**

**DATE OF ANALYSIS: 03-07-07**

**NOTE:** 1. Consult Material Safety Data Sheet (MSDS) for any potential hazards before opening sealed packaging.  
2. Purity based on metallic elements.

I = ION INTERFERENCE C=INSTRUMENT CONTAMINATION S=SOURCE CONTAMINATION



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**MATERIAL SAFETY DATA SHEET**  
COMPLIES WITH 29 CFR 1910.1200.  
OSHA HAZARD COMMUNICATION RULE

**DATE OF LAST REVISION: 06-04-96**

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## CHEMICAL IDENTITY

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LABEL IDENTITY	<b>NICKEL</b>
CHEMICAL NAME/SYNONYMS	<b>NICKEL METAL</b>
FORMULA	<b>NI</b>
CHEMICAL FAMILY	<b>METAL</b>
CAS REGISTRY NUMBER	<b>7440-02-0, LISTED IN THE TSCA INVENTORY</b>
HAZARDOUS INGREDIENTS	<b>NICKEL METAL</b>
%: <b>99.9</b>	TLV: <b>1mg/m3</b> OSHA/PEL: <b>1mg/m3</b>

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## PHYSICAL AND CHEMICAL PROPERTIES

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COLOR, FORM AND ODOR	<b>Silvery-white metallic powder, pieces, or pressed parts, odorless</b>
BOILING POINT	<b>2730°</b>
DENSITY (gm/cc)	<b>8.90 @ 25°C</b>
VAPOR PRESSURE @ 20°	<b>1mm Hg at 1810°C</b>
% VOLATILE BY VOLUME (%)	<b>NA</b>
REACTION WITH WATER	<b>None</b>
EVAPORATION RATE (H2O=1)	<b>NA</b>
SOLUBILITY IN WATER	<b>Insoluble</b>
MELTING POINT	<b>1455</b>

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## FIRE AND EXPLOSION HAZARD DATA

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FLASH POINT	<b>NA</b>
AUTOIGNITION TEMPERATURE (°C)	<b>NA</b>
FLAMMABILITY	<b>Non-combustible</b>
EXTINGUISHING MEDIA	<b>Use agents for metal fires such as dry dry graphite, MET-L-X, or TEC; odorless.</b>
SPECIAL FIRE FIGHTING PROCEDURES	<b>Wear a self-contained breathing apparatus and full protective clothing to prevent contact with skin and eyes.</b>
UNUSUAL FIRE & EXPLOSION HAZARDS	<b>Nickel powder or dust will support combustion and may form explosive mixtures in air. In a fire, nickel may form Nickel-Carbonyl, a highly toxic substance and known carcinogen.</b>



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## NICKEL MATERIAL SAFETY DATA SHEET

### HEALTH HAZARD INFORMATION

TOXICITY DATA

**\*SEE ATTACHED SHEET\***

HMIS RATING:

HEALTH: **3\*** FLAMMABILITY: **1** REACTIVITY: **0** PERSONAL PROTECTION: **X**

ROUTES OF ENTRY

INHALATION: **Yes (primary)**  
SKIN: **Yes**  
INGESTION: **Yes**

MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE: **Asthma, emphysema, etc.**

EFFECTS OF OVEREXPOSURE (acute and chronic):

INHALATION: **irritation of the mucous membrane and possibly irritation of the respiratory tract may be caused by either dust or nickel fumes. Severe overexposure may result in transient pneumonitis or asthma-like symptoms. Other symptoms include coughing, headache, nausea.**

DERMAL/EYE: **a rash may develop which may be accompanied by redness, itching and swelling. May cause sensitization dermatitis "nickel-itch" and may be accompanied, up to 7 days later, with superficial skin ulcers which may discharge and become crusted. Eye exposure may result in watering and inflammation.**

**\*\*Continued on attached sheet\*\***

CARCINOGENICITY: **Yes**

IARC MONOGRAPHS: **Yes-animal**

NTP: **Yes**

OSHA REGULATE: **Yes**

EMERGENCY FIRST AID PROCEDURES:

INGESTION: **if nickel is ingested, contact a physician and induce vomiting**

INHALATION: **remove from exposure, if breathing is difficult, contact a physician, perform artificial respiration as needed**

SKIN CONTACT: **if irritation develops, wash affected area with soap and water, if irritation persists, contact a physician**

EYE CONTACT: **if irritation develops, irrigate eyes for at least 15 minutes with water, if irritation persists, contact a physician**

### REACTIVITY DATA

STABILITY

**Stable**

CONDITIONS CONTRIBUTING TO UNSTABILITY

**None**

INCOMPATIBILITY (MATERIALS TO AVOID)

**Mineral acids, strong oxidizers, also see attached sheet\*\*\***

HAZARDOUS DECOMPOSITION PRODUCTS

**Contact with mineral acids liberated gas which may form explosive mixtures in air**

HAZARD POLYMERIZATION

**Will Not Occur**



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## NICKEL MATERIAL SAFETY DATA SHEET

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### SPECIAL PRECAUTIONS CONTINUED

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PRECAUTIONARY LABELING

**NONE**

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THE ABOVE INFORMATION IS ACCURATE TO THE BEST OF OUR KNOWLEDGE. HOWEVER, SINCE DATA, SAFETY STANDARDS AND GOVERNMENT REGULATIONS ARE SUBJECT TO CHANGE THE CONDITIONS OF HANDLING AND USE, OR MISUSE ARE BEYOND OUR CONTROL, **ANGSTROM SCIENCES** MAKE NO WARRANTY, EITHER EXPRESSED OR IMPLIED, WITH RESPECT TO THE COMPLETENESS OR CONTINUING ACCURACY OF THE INFORMATION CONTAINED HEREIN AND DISCLAIMS ALL LIABILITY FOR THE RELIANCE THEREON. USER SHOULD SATISFY HIMSELF THAT HE HAS ALL CURRENT DATA RELEVANT TO HIS PARTICULAR USE.

**NA= NOT APPLICABLE**

**ND= NO DATA FOUND**

**NR=NOT RECORDED**



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## NICKEL MATERIAL SAFETY DATA SHEET

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### REACTIVITY DATA CONTINUED

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#### CONDITIONS TO AVOID

**Nickel (usually in powdered form) is reported to be incompatible with the following: Ammonium Nitrate, Fluorine, performic acid, phosphorus, selenium and sulfur compounds**

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### SAFE HANDLING AND USE

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**STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: NIOSH-approved respiratory equipment should be worn during the clean-up of powder spills. Also wear protective equipment such as gloves and coveralls to prevent skin contact. Collect spills by: 1) wet sweeping, 2) dry sweeping using sweeping compound, or 3) by vacuuming, using a vacuum cleaner equipment with HEPA filter (High Efficiency Particulate air filter). Take care not to raise dust.**

#### WASTE DISPOSAL METHOD:

**Consult federal, state and local regulations for proper disposal.**

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### SPECIAL PROTECTIVE INFORMATION

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#### RESPIRATORY PROTECTION

**NIOSH approved dust respirators where the airborne nickel levels exceed exposure limits.**

#### LOCAL EXHAUST

**Maintain below TLV**

#### MECHANICAL (general)

**Maintain adequate ventilation**

#### PROTECTIVE GLOVES

**ND**

#### EYE PROTECTION

**Safety glasses**

#### OTHER PROTECTIVE EQUIPMENT

**Wear appropriate coveralls to prevent skin contact. Safety showers and eye-wash stations should be present in work areas.**

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### SPECIAL PRECAUTIONS

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**PRECAUTIONS TO BE TAKEN IN HANDLING/STORAGE: Keep material in closed containers. Do not store near mineral acids. Use good housecleaning practices to prevent accumulation of dust. Do not breath dust. Use approved dust respirators. Avoid prolonged or repeated skin contact. Wash or shower thoroughly after handling and before eating. Clean work clothing should be provided daily.**

#### TRANSPORTATION REQUIREMENTS

DOT CLASS:

**Not Classified**

UN NUMBER:

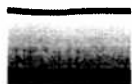
**NC**

IMCO CLASS:

**NC**

OTHER:

**ND**



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## NICKEL (ATTACHED SHEET) MATERIAL SAFETY DATA SHEET

EFFECTS OF OVEREXPOSURE (acute & chronic):

OTHER (Specify): **Nickel constitutes a possible cancer hazard and may also cause allergic reactions. Epidemiological studies have shown an excess risk of cancer of the nasal cavities and lungs in workers at nickel refineries. Ingestion of Nickel may cause nausea, vomiting and abdominal pain. Chronic exposure affects kidneys, lungs, liver, heart and brain.**

### TOXICITY DATA:

otr-ham: emb	5 umol/L	
orl-rat TDLO:	158mg/kg (MGN)	
scu-rat TDLO:	3000mg/kg/6W-I:	ETA
ims-rat TDLO:	1000mg/kg/17W-I:	CAR
ipl-rat TDLO:	1250mg/kg/17W-I:	ETA
par-rat TDLO:	40mg/kg/52W-I:	ETA
imp-rat TDLO:	250mg/kg/ :	CAR
ims-mus TDLO:	165mg/kg/2Y-I:	NEO
imp-rbt TDLO:	15mg/m3/91W-I:	ETA
ihl-gpg TCLO:	200mg/kg/21W-I:	ETA
ims-ham TDLO:	58mg/kg:	ETA
imp-rat TD:	23mg/kg:	ETA
ims-rat TD:	125mg/kg/13W-I:	NEO
ims-mus TD:	800mg/kg/13W-I:	NEO
ims-rat TD:	90mg/kg/18W-I:	ETA
ims-rat TD:	889mg/kg:	ETA
ims-rat TD:	200mg/kg/21W-I:	NEO
itr-rat LDLO:	12mg/kg	
ivn-mus LDLO:	50mg/kg	
ivn-dog LDLO:	10mg/kg	
orl-gpg LDLO:	5mg/kg	
scu-gpg LDLO:	500mg/kg	

### ADDITIONAL NICKEL INCOMPATIBLES:

**Al, AlCl<sub>3</sub>, ethylene, p-dioxin, H<sub>2</sub>, methanol, non-metals, magnesium silicate, ammonia, hydrazine, Ti + KC103.**

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MATERIAL SAFETY DATA SHEET  
COMPLIES WITH 29 CFR 1910.1200.  
OSHA HAZARD COMMUNICATION RULE

DATE OF LAST REVISION: 06-05-02

## CHEMICAL IDENTITY

LABEL IDENTITY	TITANIUM METAL		
CHEMICAL NAME/SYNONYMS	TITANIUM METAL		
FORMULA	Ti		
CHEMICAL FAMILY	METALLIC ELEMENT		
%: >99	CAS: 7440-32-6	TLV: NE	OSHA/PEL: NE

## PHYSICAL AND CHEMICAL PROPERTIES

COLOR, FORM AND ODOR	Silver gray metallic powder, pieces, no odor
BOILING POINT	3287
DENSITY (gm/cc)	4.5
VAPOR PRESSURE @ 20°	Essentially 0
% VOLATILE BY VOLUME (%)	NA
REACTION WITH WATER	None
EVAPORATION RATE (H2O=1)	NA
SOLUBILITY IN WATER	Insoluble
MELTING POINT	1668°C

## FIRE AND EXPLOSION HAZARD DATA

FLASH POINT	NA
AUTOIGNITION TEMPERATURE (°C)	1200° for solid metal in air 250° for powder
FLAMMABILITY	Non-flammable
EXTINGUISHING MEDIA	Flammable solid in powder form. If involved in fire, do not use water, carbon dioxide or halogenated extinguishers. Use dry chemical extinguishing agents, dry sand or dry ground dolomite,
SPECIAL FIRE FIGHTING PROCEDURES	Use normal firefighting procedures which include wearing NIOSH/MSHA approved self-contained breathing apparatus, flame and chemical resistant clothing; hats, boots and gloves. If without risk, remove material from fire area.
UNUSUAL FIRE & EXPLOSION HAZARDS	Titanium metal powder can burn in the atmosphere of carbon dioxide, nitrogen or air. Water applied to hot titanium may evolve hydrogen, causing an explosion. Fire may reignite after having been extinguished.



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## TITANIUM METAL MATERIAL SAFETY DATA SHEET

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### HEALTH HAZARD INFORMATION

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ROUTES OF ENTRY: **Ingestion**

EFFECTS OF OVEREXPOSURE (acute and chronic):

INHALATION: **A mild irritant. Classified as a nuisance dust.**

DERMAL/EYE: **A mild irritant to skin and eyes.**

INGESTION: **Relatively non-toxic**

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CARCINOGENICITY: **None** NTP: **No** IARC MONOGRAPHS: **No** OSHA REGULATE: **No**

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EMERGENCY FIRST AID PROCEDURES:

INGESTION: **Obtain medical attention.**

INHALATION: **Remove to fresh air. Obtain medical attention**

SKIN CONTACT: **Remove contaminated clothing, flood skin with large amounts of water. If irritation persists seek medical attention.**

EYE CONTACT: **Immediately flush eyes, including under eyelids, with large amounts of water for at least 15 minutes. Call a physician.**

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### REACTIVITY DATA

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STABILITY

**Stable**

CONDITIONS CONTRIBUTING TO UNSTABILITY

**None**

INCOMPATIBILITY (MATERIALS TO AVOID)

**Aluminum, bromine trifluoride, carbon black, carbon dioxide, metal carbonates, nitrogen, halocarbons, halogens, metal oxides, metal oxosalts, nitric acid, nitryl fluoride, oxidants, oxygen, silver fluoride, steam, acids. acids, halocarbons, halogens.**

HAZARDOUS DECOMPOSITION PRODUCTS

**Titanium Oxides**

HAZARDOUS POLYMERIZATION

**Will Not Occur**

CONDITIONS TO AVOID

**Incompatibles**

OTHER

**Titanium metal powder can burn in the atmosphere of carbon dioxide, nitrogen or air. Water applied to hot titanium may evolve hydrogen, causing an explosion.**

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### SAFE HANDLING AND USE

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STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: **Wearing full protective equipment, cover spill with dry sand or vermiculite. Mix well and carefully transfer to a container.**

WASTE DISPOSAL METHOD:

**Consult state, local or federal EPA regulations for proper disposal.**





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## TITANIUM METAL MATERIAL SAFETY DATA SHEET

### SPECIAL PROTECTIVE INFORMATION

RESPIRATORY PROTECTION	<b>High efficiency particle respirator</b>
LOCAL EXHAUST	<b>Laboratory fume hood</b>
MECHANICAL (general)	<b>Adequate for non-dusty work</b>
SPECIAL	<b>NA</b>
OTHER	<b>NA</b>
PROTECTIVE GLOVES	<b>Chemical resistant, impervious, heavy rubber or neoprene</b>
EYE PROTECTION	<b>ANSI approved safety glasses</b>
	<b>OTHER PROTECTIVE EQUIPMENT</b>
	<b>Lab coat and apron, flame and chemical resistant coveralls, eyewash capable of sustained flushing, safety drench shower and hygienic facilities for washing.</b>

### SPECIAL PRECAUTIONS

#### PRECAUTIONS TO BE TAKEN IN HANDLING/STORAGE:

**Mixing, blending, milling or grinding of dry powder should be performed only under argon or helium. Keep container tightly closed. Store in a cool, dry, well ventilated area. Wash thoroughly after use.**

TRANSPORTATION REQUIREMENTS	DOT CLASS:	<b>Flammable solid</b>
	UN NUMBER:	<b>2546</b>
	IMCO CLASS:	<b>4.2</b>
	OTHER:	<b>----</b>
PRECAUTIONARY LABELING	<b>NONE</b>	

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