MATERIAL SAFETY DATA SHEET

1. PRODUCT & COMPANY IDENTIFICATION

1.1 Product Name: Gallium Arsenide Phophide (GsAsP) Chip
   Style/Item No.: GsAsP (HO,HY,SO,HOD TYPE )

1.2 Company Identification:
   Supplier: TYNTEK CORPORATION
   Name: Mr. C. K. Perng
   Address: 1378 Ren-Ay Rd.Chunan-Jenn.Miaulih350, Taiwan, R.O.C.
   Telephone: 037-582997
   Facsimile: 037-580866
   e-mail: 187@serv.tyntek.com.tw

1.3 Emergency Contact:
   Supplier: TYNTEK CORPORATION
   Name: Mr. James Kung
   Telephone: 037-582997

1.4 Manufacturer:
   Supplier: TYNTEK CORPORATION
   Name: Mr. C. K. Perng
   Address: 1378 Ren.Ay Rd.Chunan-Jenn.Miaulih350, Taiwan, R.O.C.
   Telephone: 037-582997

2. COMPOSITION/INFORMATION ON INGREDIENTS

2.1 Component:
   Epitaxial layer:
   Gallium arsenide phosphide(GaAs(1-x)P(x)) less than 30%
   
   (0 < x < 1)
   Gallium arsenide or gallium phosphide more than 70%

2.2 Hazard Identification:
   T, Toxic

2.3 CAS NO.:
   12044-20-1(GaAsP),1303-0030(GaAs),12063-98-8(GaP)

2.4 UN Class:
   Not assigned

2.5 UN NO.:
   Not assigned

3. HAZARDS IDENTIFICATION

3.1 MOST IMPORTANT HAZARDS
   Adverse Human Health Effects:
   Only those arsenic compounds are considered toxic which may result from thermal decomposition and/or chemical reactions of GaAs, esp.
   — Diarsenic trioxide
   — Arsenic hydride
Poisoning by arsenic compounds can cause irritation of skin and mucous membranes; can damage heart, liver, blood, nerves and metabolism. Poisoning may result from inhalation and ingestion of dust and mist which occur when handling substance. As result of thermal decomposition arsenic is released. Arsenic can cause cancer in humans.

### 4. FIRST AID MEASURES

| 4.1 Potential routes of exposure | Inhalation, shin, oral, and eye |
| 4.2 After skin contact | Wash with water and soap. |
| 4.3 After eye contact | Wash eyes with plenty of water for at least 15 minutes. |
| 4.4 After ingestion | Wash a mouth with plenty of water, and vomit intentionally. Get medical attention. |
| 4.5 After inhalation | Remove form exposure area to fresh air immediately, get medical attention immediately. |

### 5. FIRE FIGHTING MEASURES

| 5.1 General | Gallium arsenide Phosphide epitaxial wafer is nonflammable. It is subject to decomposition at high temperatures. No special extinguishing media needed, adjust extinguishing measures to environment. |
| 5.2 Appropriate extinguishing media | None |
| 5.3 Unsuitable extinguishing media (for safety reasons) | None |
| 5.4 Special hazards caused by substance, combustion products and emerging gases | Combustion products which are $\text{As}_2\text{O}_3$, arsine gas, and arsenic fumes can be hazardous. |
| 5.5 Special protection for fire-fighters | Respiratory protection because of $\text{As}_2\text{O}_3$, arsine, and arsenic fumes. |

### 6. ACCIDENTAL RELEASE MEASURES

| 6.1 Personal protection | Take precautions during mechanical working and chemical Reactions. Provide good ventilation in manufacturing rooms, exhausts at machines, avoid skin contact. |
6.2 Environmental protection: Do not pass fine-grained GaAsP epitaxial wafer (suspensions) into Sewerage system (see #13.1)

6.3 Methods for cleaning up: Wipe with pulp and place in suitable close containers. Sweep up with special vacuum cleaner and place in suitable close containers.

7. HANDLING AND STORAGE

7.1 Handling, measures for safe handling: Avoid formation of dust and wear gloves when handling. (See #6.1)

7.2 Storage, requirements to storage rooms, containers and conditions: Keep dry, close container and store in the roomtemperature.

8. EXPOSURE CONTROL AND PERSONAL PROTECTION

8.1 Design of technical equipment: Provide exhausts/covers for equipment and machines where formation of dust and gaseous arsenic compounds is to be expected.

8.2 Occupational exposure limit: Not available for GaAsP epitaxial wafer.

<table>
<thead>
<tr>
<th>Compound</th>
<th>OSHA PEL TWA</th>
<th>OSHA TLV TWA</th>
<th>ACGIH TWA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarsenic trioxide</td>
<td>0.01 mg/m³</td>
<td>0.01 mg/m³</td>
<td></td>
</tr>
<tr>
<td>Arsine</td>
<td>0.05 ppm</td>
<td>0.05 ppm</td>
<td></td>
</tr>
<tr>
<td>Arsenic</td>
<td>0.01 mg/m³</td>
<td>0.01 mg/m³</td>
<td></td>
</tr>
</tbody>
</table>

8.3 Personal protection:

<table>
<thead>
<tr>
<th>Protection</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory</td>
<td>Wear Appropriate NIOSH/MSHA approved respirator.</td>
</tr>
<tr>
<td>Hand protection</td>
<td>Chemical-resistant gloves</td>
</tr>
<tr>
<td>Eye protection</td>
<td>Full facemask for dusts, vapors.</td>
</tr>
<tr>
<td>Body protection</td>
<td>Depends on working place(coat, suit, overall, etc.)</td>
</tr>
</tbody>
</table>

8.4 Further information: Avoid skin contact, do not eat, smoke, drink during work, do not keep food in working rooms, wear appropriate clothing, change soiled clothing, wash hands after work.
9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Description:

<table>
<thead>
<tr>
<th>Property</th>
<th>GaAs</th>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Solid substance (wafers)</td>
<td>Solid (wafers)</td>
</tr>
<tr>
<td>Color</td>
<td>Grey with metallic sheen</td>
<td>Yellow/Orange/Red</td>
</tr>
<tr>
<td>Odor</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

9.2 pH
Not applicable

9.3 Physical and safety data:

<table>
<thead>
<tr>
<th>Property</th>
<th>GaAs</th>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melting point/melting area</td>
<td>1238°C</td>
<td>1465°C</td>
</tr>
<tr>
<td>Boiling point/boiling area</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Thermal decomposition</td>
<td>Begin at approx. 300°C</td>
<td>slightly</td>
</tr>
<tr>
<td>Flash point</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Inflammability</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Explosive hazard/limits</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Fire promoting properties</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Vapor pressure</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Density</td>
<td>5.31 g/cm³ at 300K</td>
<td>4.13 g/cm³ at 300K</td>
</tr>
<tr>
<td>Solubility</td>
<td>Not soluble in water</td>
<td>Not soluble in water</td>
</tr>
</tbody>
</table>

9.4 Further information
Forms with moisture in presence of atmospheric Oxygen thin, soluble in water, toxic arsenic layer on the surface.

10. STABILITY AND REACTIVITY

10.1 Conditions to avoid: Heating up in air outside closed equipment.

10.2 Materials to avoid: Finely divided GaAsP epitaxial wafer can react vigorously with strong acids and oxidizers. Avoid high temperatures and steam to prevent release of arsenic fumes or arsine gas.

10.3 Hazardous decomposition products and reactions: GaAsP epitaxial wafer when exposed to high temperatures or in contact with strong acids or oxidizers can generate toxic arsenic fumes or arsine gas.

11. TOXICOLOGICAL INFORMATION

11.1 Toxicological impact on health:

<table>
<thead>
<tr>
<th>Property</th>
<th>GaAs</th>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal toxicity</td>
<td>Intraperitoneal LD30(rat)</td>
<td>10 g/Kg</td>
</tr>
</tbody>
</table>

The data of GaAsP epitaxial wafer is not available. The information of GaAs and GaP are as follows.

GaAs

GaP

Intraperitoneal LD30(rat) 10 g/Kg
After inhalation:
For human beings the threshold of response to arsenic compounds (with regard to As in total dust) is:
ACGIH TLV TWA 0.01 mg/m³.
May cause inflammation of mucous membranes in Respiratory tract.

After ingestion:
Ingestion of arsenic compounds of 50 μg/kg/day causes Disturbances of digestive tract and kidneys, changes of blood, skin irritation etc.

After skin contact:
Arsenic compounds may cause dermatitis of skin.

11.2 Chronic effect:
Arsenic compounds may cause cancer of lungs and skin in human beings.
GaAs was dosed for the hamster in amounts of 0.25mg/time 1time/week×15weeks, but lung cancer wasn't admitted.

11.3 Carcinogenicity:
IARC: Human carcinogen(group 1)
OSHA: Cancer hazard
NTP: Human carcinogen

12. ECOLOGICAL INFORMATION

12.1 Degradability and biodegradability:
Not degradable.

12.2 Biological accumulation:
Not available

12.3 Toxicity to fish:
Diarsenic trioxide:
LC50 goldfish 32 mg/1/7 days
LC50 water organisms 10-1mg/1/96 hours
Aquatic toxicity rate TLm96: 10-1 ppm
5.3 mg/l poisonous for trout after 8 days, from 1 mg/l carcinogen for water organisms.
13.1 Product:
Compact material is recycled (e.g., controlled thermal decomposition) or disposed according to RCRA Hazardous Waste Regulations or state regulations (in United States).

13.2 Soiled package:
Special package for GaAs wafers can be reused after special cleaning, other package contaminated by As to be disposed of in controlled dumps.

14. TRANSPORT INFORMATION
14.1 Transport classification:
UN-number Not assigned
(ADR/RID: GGVS/GGVE; AND/ADNR: IMDG/GGVSee; ICAO-TI: IATA-DGR) Not applicable

14.2 Transport information:
There are no special regulations since GaAsP epitaxial wafer is not hazardous under normal transport conditions (fire and impact of acids excluded). This is also true, if GaAsP epitaxial wafer is released from package in an accident.

15. REGULATORY INFORMATION
Follow all regulations in your country.

16. OTHER INFORMATION
16.1 References:
1) ACGIH TLVs and BEIs Threshold Limit Values for Chemical Substances and Physical Agents (1998)
2) SAX's Dangerous Properties of Industrial Materials (1995)
3) Roschina T.A.: Gig Tr Prof Zabol, 10: 30-33, (1966)
4) Fadeev A.I.: Gig Tr Prof Zabol, 24(3), 45, (1980)
5) MSDS Freiberger Compound Materials GmbH (1997)
6) NTP Chemical Repository Gallium Arsenide (Radian Corporation 1990)
8) MSDS Hewlett-Packard Opto Electronics Division (1996)

Aforementioned data are based on our present knowledge and experience. The data sheet describes our product with regard to safety requirements but does not guarantee properties. The buyer of our products is responsible for observing valid laws and regulations.