Material Safety Data Sheet (MSDS)

Tetrakis(ethylmethylamido)zirconium(IV)

Date of Issue: September, 04, 2012
Revision: 1.5

1. Product and company identification

1.1 Product Name: Tetrakis(ethylmethylamido)zirconium(IV)

1.2 Recommended use of the chemical and restrictions on use: Semiconductor Processing

1.3 Manufacturer/Supplier/Distributor Information:
- Name: DNF Co., Ltd.
- Address: 142, Daehwa-ro, 132beon-gil, Daedeok-ku, Daejeon, 306-802, Republic of Korea
- Telephone: +82-42-932-7939
- Fax: +82-42-932-7947
- Emergency phone number: +82-31-205-7939

2. Hazards identification

2.1. Hazard-Risk Classification
- Flammable Liquid: Category 2
- Substances and mixtures which, in contact with water, emit flammable gases: Category 2
- Skin Corrosion/Irritation: Category 1
- Serious eye damage/eye irritation: Category 1
- Reproductive Toxicity: Category 2
- Specific Target Organ Toxicity - single exposure: Category 2
- Specific Target Organ Toxicity - single exposure: Category 3 (respiratory tract irritation)
- Specific Target Organ Toxicity - single exposure: Category 3 (narcotic effects)
- Aspiration Hazard: Category 1

2.2 Label elements including precautionary statements
- Symbol:
- **Signal Word:** Danger

- **Hazard-Risk Statement**
  - H225 Highly flammable liquid and vapour
  - H261 In contact with water releases flammable gas
  - H304 May be fatal if swallowed and enters airways
  - H315 Causes skin irritation
  - H319 Causes serious eye irritation
  - H335 May cause respiratory irritation
  - H336 May cause drowsiness or dizziness
  - H361 Suspected of damaging fertility or the unborn child
  - H371 May cause damage to organs

- **Precautionary Statement**

  - **Prevention**
    - P201 Obtain special instructions before use.
    - P202 Do not handle until all safety precautions have been read and understood.
    - P210 Keep away from heat/sparks/open flames/hot surfaces. – No smoking.
    - P223 Keep away from any possible contact with water, because of violent reaction and possible flash fire.
    - P233 Keep container tightly closed.
    - P240 Ground/bond container and receiving equipment.
    - P241 Use explosion-proof electrical/ventilating/lighting/.../ equipment.
    - P242 Use only non-sparking tools.
    - P243 Take precautionary measures against static discharge.
    - P260 Do not breathe dust/fume/gas/mist/vapours/spray.
    - P261 Avoid breathing dust/fume/gas/mist/vapours/spray.
    - P264 Wash ... thoroughly after handling.
    - P270 Do not eat, drink or smoke when using this product.
    - P271 Use only outdoors or in a well-ventilated area.
    - P280 Wear protective gloves/protective clothing/eye protection/face protection.
    - P281 Use personal protective equipment as required.
    - P231+P232 Handle under inert gas. Protect from moisture.

- **Response**
  - P312 Call a POISON CENTER or doctor/physician if you feel unwell.
  - P321 Specific treatment (see ... on this label).
  - P331 Do NOT induce vomiting.
  - P362 Take off contaminated clothing and wash before reuse.
P301+P310 IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician.
P302+P352 IF ON SKIN: Wash with plenty of soap and water.
P303+P361+P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304+P340 IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P308+P313 IF exposed or concerned: Get medical advice/attention.
P309+P311 IF exposed or if you feel unwell: Call a POISON CENTER or doctor/physician.
P332+P334 Brush off loose particles from skin. Immerse in cool water/wrap in wet bandages.
P337+P313 If eye irritation persists: Get medical advice/attention.
P370+P378 In case of fire: Use ... for extinction.

- Storage
  P405 Store locked up.
P402+P404 Store in a dry place. Store in a closed container.
P403+P233 Store in a well-ventilated place. Keep container tightly closed.
P403+P235 Store in a well-ventilated place. Keep cool.

- Disposal
  P501 Dispose of contents/container to ...

2.3 Other Hazard-Risk which are not included in the classification criteria (e.g. dust explosion hazard):
- NFPA Rating - Health Hazard: 3, Fire: 4, Reactivity Hazard: 2

3. Composition/Information on ingredients

3.1 Chemical Name: Tetrakis(ethylmethylamido)zirconium(IV)
3.2 Other name: Tetrakis(ethylmethylamino)zirconium(IV)
  Zirconium(IV) tetrakis(ethylmethylamide)
  N-ethylmethanamine zirconium(IV) salt
3.3 CAS number: 175923-04-3
3.4 EN number: -
3.5 Molecular Formula: C_{12}H_{32}N_{4}Zr
3.6 Content (%): >99.5%
4. First aid measures

4.1 Eye contact
Immediately flush the eyes with copious amounts of water for at least 10-15 minutes.
A victim may need assistance in keeping their eye lids open.
Get immediate medical attention.

4.2 Skin contact
Wash off immediately with plenty of water for at least 15 minutes.
Immediately remove contaminated clothing, and any extraneous chemical, if possible to do so without delay.

4.3 Inhalation
Remove the victim to fresh air.
Closely monitor the victim for signs of respiratory problems, such as difficulty in breathing, coughing, wheezing, or pain.
In such cases seek immediate medical assistance.

4.4 Ingestion
Never give anything by mouth to an unconscious person.
Immediately give large quantities of water to drink.
Induce vomiting if person is conscious. Prevent aspiration of vomit.
Turn victim's head to the side.

4.5 Indication of immediate medical attention and notes for physician
Seek medical advice. If breathing has stopped or is labored, give assisted respirations.
Supplemental oxygen may be indicated.
If the heart has stopped, trained personnel should begin cardiopulmonary resuscitation immediately.

5. Fire-Fighting measures

5.1 Suitable (and unsuitable) extinguishing media
Suitable: carbon dioxide or dry powder
Unsuitable: Do not use water.

5.2 Specific hazards arising from the chemical (e.g. nature of any hazardous combustion products):
- Products of Combustion: amine, CO, CO₂, NOₓ ZrO₂

5.3 Special protective equipment and precautions for fire-fighters
Wear self contained breathing apparatus for fire fighting if necessary.
6. Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures
Wear suitable protective clothing, gloves and eye/face protection.
Use self-contained breathing apparatus and chemically protective clothing.
Remove all sources of ignition.
Evacuate personnel to safe areas.

6.2 Environmental precautions and protective procedures
Do not allow material to enter drains or streams.

6.3 Methods and materials for containment and cleaning up
Approach suspected leak areas with caution.
Absorb with inert absorbent materials such as: Dry sand, Vermiculite, Activated charcoal.
Place in appropriate chemical waste container.

7. Handling and storage

7.1 Precautions for safe handling
Avoid contact with skin and eyes.
Avoid inhalation of vapor or mist.
Keep away from sources of ignition - No smoking.
Take measures to prevent the build up of electrostatic charge.
Keep away from incompatibles such as oxidizing agent, acids.

7.2 Conditions for safe storage (including any incompatibilities)
Keep container tightly closed in a dry and well-ventilated place.
Containers which are opened must be carefully resealed and kept upright to prevent leakage.
Store in cool place.
Do not store together with oxidizing and acidic materials.
Protect from humidity and water.
Keep container tightly sealed.

8. Exposure controls & personal protection

8.1 Control parameters (e.g. occupational exposure limit values, biological limit values)
- ACGIH: TWA 5mg/m$^3$
  STEL 10mg/m$^3$
8.2 Appropriate engineering controls
Maintain process conditions to ensure temperature is below product flashpoint.
Ensure adequate ventilation.
Provide readily accessible eye wash stations and safety showers.
Provide natural or explosion-proof ventilation adequate to ensure concentrations are kept below exposure.

8.3 Personal protective equipment
- Respiratory protection
  Use respirators and components tested and approved under appropriate government shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination(US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator.
- Eye protection
  Chemical safety goggles.
- Hands protection
  Compatible chemical-resistant gloves.
- Body protection
  Choose body protection according to the amount and concentration of the dangerous substance at the work place.

9. Physical and chemical properties

9.1 Appearance
- **physical state**: Liquid
- **color**: Colorless to yellow

9.2 Odour
- **Odour**: amine odor

9.3 Odour threshold
- **Odour threshold**: No data available

9.4 pH
- **pH**: No data available

9.5 Melting point/freezing point
- **Melting point/freezing point**: <-20°C

9.6 Initial boiling point and boiling range
- **Initial boiling point and boiling range**: 81°C at 0.1 torr

9.7 Flashing point
- **Flashing point**: 10 °C

9.8 Evaporation rate
- **Evaporation rate**: No data available

9.9 Flammability (solid, gas)
- **Flammability (solid, gas)**: Not applicable

9.10 Upper/lower flammability or explosive limits
- **Upper/lower flammability or explosive limits**: No data available

9.11 Vapor pressure
- **Vapor pressure**: 1.0 torr at 70°C

9.12 Solubility in water
- **Solubility in water**: React Violently

9.13 Vapor density
- **Vapor density**: No data available
9.14 Relative density: 1.049 g/mL at 25 °C
9.15 Partition coefficient: n-octanol/water: No data available
9.16 Auto-ignition temperature: No data available
9.17 Decomposition temperature: No data available
9.18 Viscosity: No data available
9.19 Formula mass: 323.62 g/mol

10. Stability and reactivity

10.1 Chemical stability and possibility of hazardous reactions: Stable in sealed containers stored under a dry inert atmosphere.
10.2 Possibility of hazardous reactions: no hazardous polymerization
10.3 Conditions to avoid (e.g. static discharge, shock or vibration, etc) Incompatible materials: Heat, flames and sparks. Exposure to moisture.
10.4 Incompatible materials: Strong oxidizing agents and halogens, and strong acids, alcohol
10.5 Hazardous decomposition products
   CO, CO₂, Nitrogen oxides, zirconium oxides

11. Toxicological information

11.1 Information on the likely routes of exposure
   - Inhalation: Harmful if inhaled. Causes respiratory tract irritation. Vapours may cause drowsiness and dizziness.
   - Ingestion: Harmful if swallowed. Aspiration hazard if swallowed - can enter lungs and cause damage.
   - Eye: Causes serious eye irritation.
   - Skin: Harmful if absorbed through skin. Causes skin irritation.

11.2 Health hazards information
   - Acute toxic: No data available
   - Skin corrosive/irritant: Causes burns.
   - Serious eye damage/eye irritation: Causes burns.
   - Respiratory sensitization: No data available
   - Skin sensitization: No data available
   - Carcinogenicity: IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
   - Germ Cell Mutagenicity: No data available
   - Reproductive toxicity: No data available
12. Ecological information

12.1 Aquatic and terrestrial ecotoxicity: No data available
12.2 Persistence and degradability: No data available
12.3 Bioaccumulative potential: No data available
12.4 Mobility in soil: No data available
12.5 Other adverse effects: No data available

13. Disposal considerations

13.1 Disposal method
Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

14.1 UN number: 3399
14.2 UN proper shipping name: Organometallic substance, liquid, water-reactive, flammable (Tetrakis(ethylmethylamido)zirconium(IV))
14.3 Transport hazard class: 4.3
14.4 Packing group (if applicable): Ⅱ
14.5 Marin pollution (yes/no): No data available
14.6 Special precaution which a user to be aware of or needs to comply with in connection with transport or conveyance either within or outside their premises:
- F-G / S-N

15. Regulatory information

15.1 Industrial Safety and Health Act: TWA: 5mg/m³, STEL: 10mg/m³
15.2 **Toxic Chemical Control Act:** Title compound not listed.

15.3 **Dangerous Material Safety Control Act:** 3rd Group Spontaneously Combustible Materials and Water-Prohibitive Materials (Organic metal compounds)

15.4 **Wastes Management Act:** Designated Waste

15.5 **Other requirements in domestic and other countries:**
- OSHA Hazards: Flammable liquid, Water Reactive, Target Organ Effect, Irritant, Teratogen
- TSCA Status: On TSCA Inventory
- **Hazard symbols:**
  - F Highly flammable
  - Xi Irritant
- **Risk phrases:**
  - R11 Highly flammable
  - R14 Reacts violently with water.
  - R36/37/38 Irritating to eyes, respiratory system and skin.
- **Safety phrases:**
  - S16 Keep away from sources of ignition – No smoking.
  - S26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
  - S36 Wear suitable protective clothing.

16. **Other information**

16.1 **Information source and references**
- This safety datasheet complies with the requirements of Regulation (EC) No. 1907/2006.
- http://www.kosha.or.kr

16.2 **Issuing date:** June 14, 2007

16.3 **Revision number and date**
- Revision number: 5
- Revision Date: September, 04, 2012

16.4 **Others:** No data available

Since the Company shall have no control of the use of the product described herein, the company assumes no liability for loss or damage incurred from the proper or improper use of such product.

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