SECTION 1: IDENTIFICATION OF THE PRODUCT AND OF THE COMPANY

1.1 Product identifiers
Product Name: ACS Material Graphene Dispersion in NMP
Brand: ACS Material LLC
CAS-No.: 7782-42-5 (graphene); 872-50-4 (NMP)

1.2 Relevant identified uses of the substance or mixture and uses advised against
Identified uses: Laboratory chemicals, Manufacturing of substances

1.3 Details of the supplier of the safety data sheet
Company: ACS MATERIAL LLC
959 E Walnut St. Suite 100
Pasadena, CA 91106
USA
Telephone: +1 (866)-227-0656
Fax: +1 (781)-518-0284

1.4 Emergency telephone number
Emergency Phone #: +1 (866)-227-0656

SECTION 2: HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture
Classification according to 29 CFR 1910 (OSHA HCS)
Flammable liquids (Category 4), H227
Skin irritation (Category 2), H315
Eye irritation (Category 2A), H319
Reproductive toxicity (Category 1B), H360
Specific target organ toxicity - single exposure (Category 3), Respiratory system, H335
For the full text of the H-Statements mentioned in this Section, see Section 16.

Classification according to EU Directives 67/548/EEC or 1999/45/EC
R61
Xi Irritant R36/37/38
For the full text of the R-phrases mentioned in this Section, see Section 16.
2.2 GHS Label elements, including precautionary statements

Pictogram

Signal word
Danger

Hazard statement(s)
- H227: Combustible liquid.
- H315: Causes skin irritation.
- H319: Causes serious eye irritation.
- H335: May cause respiratory irritation.
- H360: May damage fertility or the unborn child.

Precautionary statement(s)
- 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.
- P261: Avoid breathing dust/ fume/ gas/ mist/ vapours/ spray.
- P264: Wash skin thoroughly after handling.
- P271: Use only outdoors or in a well-ventilated area.
- P280: Wear protective gloves/ protective clothing/ eye protection/ face protection.
- P302 + P352: IF ON SKIN: Wash with plenty of soap and water.
- P304 + P340 + P312: IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER/doctor if you feel
Safety Data Sheet – Graphene Dispersion in NMP

unwell.

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.

P332 + P313 If skin irritation occurs: Get medical advice/attention.

P337 + P313 If eye irritation persists: Get medical advice/attention.

P362 Take off contaminated clothing and wash before reuse.

P370 + P378 In case of fire: Use dry sand, dry chemical or alcohol-resistant Foam to extinguish.

P403 + P233 Store in a well-ventilated place. Keep container tightly closed.

P403 + P235 Store in a well-ventilated place. Keep cool.

P405 Store locked up.

P501 Dispose of contents/container to an approved waste disposal plant.

Supplemental Hazard Statements
None
Restricted to professional users.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS
None.

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

<table>
<thead>
<tr>
<th>Substance name</th>
<th>ACS Material Graphene Dispersion in NMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAS-No</td>
<td>7782-42-5</td>
</tr>
<tr>
<td>EC-No.</td>
<td>231-955-3</td>
</tr>
<tr>
<td>Synonyms</td>
<td>Graphene, GNP</td>
</tr>
<tr>
<td>Molecular weight</td>
<td>12.01 g/mol</td>
</tr>
<tr>
<td>Linear formula</td>
<td>C</td>
</tr>
<tr>
<td>CAS-No</td>
<td>872-50-4</td>
</tr>
</tbody>
</table>
Safety Data Sheet – Graphene Dispersion in NMP

EC-No. : 212-828-1
Synonyms : 1-Methyl-2-pyrrolidone
N-Methyl-2-pyrrolidone
NMP
M-PYROL™
Molecular weight : 99.13 g/mol
Linear formula : C₅H₇NO

Hazardous ingredients

<table>
<thead>
<tr>
<th>Components</th>
<th>Concentration</th>
<th>CAS No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphene (C)</td>
<td>~4 wt%</td>
<td>7782-42-5</td>
</tr>
<tr>
<td>NMP</td>
<td>94.9 wt%</td>
<td>872-50-4</td>
</tr>
</tbody>
</table>

For the full text of the phrases mentioned in this Section, see Section 16.

Hazardous impurities: None known.

SECTION 4: FIRST AID MEASURES

4.1 Description of first aid measures

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance. Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11.

4.3 Indication of any immediate medical attention and special treatment needed
No data available.
SECTION 5: FIREFIGHTING MEASURES

5.1 Extinguishing media
Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture
Carbon oxides, nitrogen oxides (NO\textsubscript{x}).

5.3 Advice for firefighters
Wear self-contained breathing apparatus for firefighting if necessary.

5.4 Further information
Use water spray to cool unopened containers.

SECTION 6: ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Use personal protective equipment. Avoid breathing vapours, mist or gas. Ensure adequate ventilation.

Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.

For personal protection see section 8.

6.2 Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up
Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13). Keep in suitable, closed containers for disposal.

6.4 Reference to other sections
For disposal see section 13.

SECTION 7: HANDLING AND STORAGE

7.1 Precautions for safe handling
Suitable extinguishing media
Avoid exposure - obtain special instructions before use. Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.

Keep away from sources of ignition - No smoking. Take measures to prevent the build-up of electrostatic charge.
For precautions see section 2.2.

7.2 **Conditions for safe storage, including any incompatibilities**

Store in cool place. 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 under inert gas. Moisture sensitive.

Storage class (TRGS 510): Non-combustible, acute toxic Cat.3 / toxic hazardous materials or hazardous materials causing chronic effects.

7.3 **Specific end use(s)**

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated.

**SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION**

8.1 **Control parameters**

**Components with workplace control parameters**

<table>
<thead>
<tr>
<th>Components</th>
<th>CAS-No.</th>
<th>Value</th>
<th>Control Parameters</th>
<th>Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphene (C)</td>
<td>7782-42-5</td>
<td>TWA 15.000000 Million</td>
<td>USA. Occupational Exposure Limits (OSHA) - Table Z-3 Mineral Duffs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>particles per cubic foot</td>
<td></td>
<td>Remarks: Millions of particles per cubic foot of air, based on impinger samples counted by light-field techniques. mppcf X 35.3 = million particles per cubic meter = particles per c.c. Also see specific listing for Graphene (synthetic).</td>
</tr>
<tr>
<td>N-methyl-2-pyrrolidone</td>
<td>872-50-4</td>
<td>TWA 10.000000 ppm</td>
<td>USA. Workplace Environmental Exposure Levels (WEEL)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Remarks: Skin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PEL</td>
<td>California permissible exposure limits for chemical contaminants (Title 8, Article 107)</td>
<td>Skin</td>
</tr>
</tbody>
</table>

Also see specific listing for Graphene (synthetic).
Biological occupational exposure limits

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Parameters</th>
<th>Value</th>
<th>Biological specimen</th>
<th>Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>N-methyl-2-pyrrolidone</td>
<td>872-50-4</td>
<td>5-Hydroxy-Nmethyl-2-pyrrolidone</td>
<td>100.0000 mg/l</td>
<td>Urine</td>
<td>ACGIH - Biological Exposure Indices (BEI)</td>
</tr>
</tbody>
</table>

Remarks: End of shift (As soon as possible after exposure ceases)

Derived No Effect Level (DNEL)

<table>
<thead>
<tr>
<th>Application Area</th>
<th>Exposure routes</th>
<th>Health effect</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workers</td>
<td>Skin contact</td>
<td>Acute systemic effects</td>
<td>208mg/kg BW/d</td>
</tr>
<tr>
<td>Workers</td>
<td>Skin contact</td>
<td>Long-term systemic effects</td>
<td>19.8mg/kg BW/d</td>
</tr>
</tbody>
</table>

Predicted No Effect Concentration (PNEC)

<table>
<thead>
<tr>
<th>Compartment</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>5 mg/l</td>
</tr>
<tr>
<td>Soil</td>
<td>0.138 mg/kg</td>
</tr>
<tr>
<td>Marine water</td>
<td>0.025 mg/kg</td>
</tr>
<tr>
<td>Fresh water</td>
<td>0.25 mg/l</td>
</tr>
<tr>
<td>Fresh water sediment</td>
<td>0.805 mg/kg</td>
</tr>
<tr>
<td>Onsite sewage treatment plant</td>
<td>10 mg/l</td>
</tr>
</tbody>
</table>

8.2 Exposure controls

Appropriate engineering controls

Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

8.3 Personal protective equipment

**Eye/face protection**
Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

**Skin protection**
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove’s outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices.
Wash and dry hands.
The selected protective gloves must satisfy the specifications of EU Directive.
89/686/EEC and the standard EN 374 derived from it.

Full contact
Material: butyl-rubber
Minimum layer thickness: 0,3 mm
Break through time: 480 min
Material tested: Butoject® (KCL 897 / Aldrich Z677647, Size M)

Splash contact
Material: Nature latex/chloroprene
Minimum layer thickness: 0,6 mm
Break through time: 30 min
Material tested: Lapren® (KCL 706 / Aldrich Z677558, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de,
test method: EN374

If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

**Body Protection**

Choose body protection in relation to its type, to the concentration and amount of dangerous substances, and to the specific work-place. Impervious clothing recommended. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

**Respiratory protection**

Where risk assessment 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. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

**Control of environmental exposure**

Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

**SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES**

9.1 **Information on basic physical and chemical properties**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>Appearance</td>
</tr>
<tr>
<td></td>
<td>Colour: colourless</td>
</tr>
<tr>
<td>2)</td>
<td>Odour</td>
</tr>
<tr>
<td>3)</td>
<td>Odour Threshold</td>
</tr>
<tr>
<td>4)</td>
<td>pH</td>
</tr>
</tbody>
</table>
5) Melting point/freezing point  -24 °C (-11.2 °F)
6) Initial boiling point and boiling range  202 °C
7) Flash point  91 °C - closed cup
8) Evaporation rate  No data available
9) Flammability (solid, gas)  No data available
10) Upper/lower flammability or explosive limits  Upper explosion limit: 9.5 % (V)
    Lower explosion limit: 1.3 % (V)
11) Vapour pressure  0.39 - 0.43 hPa at 20 °C
    1.32 hPa at 40 °C
12) Vapour density  3.42 - (Air = 1.0)
13) Relative density  1.028 g/mL at 25 °C
14) Water solubility  No data available
15) Partition coefficient: n-octanol/water  log Pow: -0.46
16) Auto-ignition temperature  No data available
17) Decomposition temperature  No data available
18) Viscosity  3000-5000 mPa·s
19) Explosive properties  No data available
20) Oxidizing properties  No data available

9.2 Other safety information
No data available

SECTION 10: STABILITY AND REACTIVITY

10.1 Reactivity
No data available

10.2 Chemical stability
Stable under recommended storage conditions, able to form peroxide composition in the air.

10.3 Possibility of hazardous reactions
No data available

10.4 Conditions to avoid
Heat, flames and sparks.

10.5 Incompatible materials
Strong acids, bases, strong oxidizing agents.

10.6 Hazardous decomposition products
Carbon oxides and nitrogen oxides.
In the event of fire: see section 5.
SECTION 11: TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity

LD50 Oral
rat - 3.914 mg/kg

Inhalation LC50
LC50 Inhalation: > 5130 mg/m³ (Rat 4 h)
Remarks: Lungs, Thorax, or Respiration: Other changes.

LDLO Inhalation
rat - 4 h - > 5100 ppm

LD50 Dermal
rabbit - 8.000 mg/kg

Other information on acute toxicity
No data available

Skin corrosion/irritation
No data available

Serious eye damage/eye irritation
Eyes - rabbit
Result: Eye irritation

Respiratory or skin sensitisation
No data available

Germ cell mutagenicity
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.

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity

Damage to fetus possible, occasional lethargy or irregular breathing.

Specific target organ toxicity - single exposure
Inhalation - May cause respiratory irritation.

Specific target organ toxicity - repeated exposure
No data available
Aspiration hazard
No data available

Additional Information
RTECS: UY5790000
Prolonged or repeated exposure can cause: vomiting, diarrhea and/or abdominal pain. Rats exposed to 1-methyl-2-pyrrolidinone at a concentration of 1 mg/L as an aerosol for 10 days showed depletion of hematopoietic cells in the bone marrow and atrophy of the lymphoid tissues of the thymus, spleen, and lymph nodes.
Bone marrow - Irregularities - Based on Human Evidence

SECTION 12: ECOLOGICAL INFORMATION

12.1 Toxicity
Toxicity to fish
LC50 - other fish - 4,000 mg/l - 96 h
LC50 - Leuciscus idus (Golden orfe) - > 500 mg/l - 96 h

Toxicity to daphnia and other aquatic invertebrates
EC50 - Daphnia magna (Water flea) - > 1,000 mg/l - 24 h

Toxicity to bacteria
LC50 - Bacteria - > 9,000 mg/l

12.2 Persistence and degradability
Biodegradability
Result: 90 % - Readily biodegradable

12.3 Bioaccumulative potential
No data available

12.4 Mobility in soil
No data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted.

12.6 Other adverse effects
No data available

SECTION 13: DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods
Product
This combustible material may be burned in a chemical incinerator equipped with an afterburner and scrubber. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.
Contaminated packaging
Dispose of as unused product.

SECTION 14: TRANSPORT INFORMATION

UN number
ADR/RID: 1993
IMDG: - IATA: -

UN proper shipping name
ADR/RID: Combustible liquid, n.o.s. (N-methyl-2-pyrrolidone)
IMDG: Not dangerous goods
IATA: Not dangerous goods

Transport hazard class(es)
ADR/RID: NONE
IMDG: - IATA: -

Packaging group
ADR/RID: III
IMDG: - IATA: -

Environmental hazards
ADR/RID: no IMDG Marine pollutant: no IATA: no

Special precautions for user
no data available

SECTION 15: REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Authorisations and/or restrictions on use
N-methyl-2-pyrrolidone CAS-No.: 872-50-4
Candidate List of Substances of Very High Concern for Authorisation
Toxic for reproduction (article 57c)
ED/31/2011

SARA 302 Components
No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
The following components are subject to reporting levels established by SARA Title III, Section 313:
N-methyl-2-pyrrolidone CAS-No. Revision Date
SARA 311/312 Hazards
Fire Hazard, Chronic Health Hazard

Massachusetts Right To Know Components
N-methyl-2-pyrrolidone

Pennsylvania Right To Know Components
N-methyl-2-pyrrolidone

New Jersey Right To Know Components
N-methyl-2-pyrrolidone

SECTION 16: OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3.

Eye Irrit.  Eye irritation
Flam. Liq.  Flammable liquids
H227  Combustible liquid.
H315  Causes skin irritation.
H319  Causes serious eye irritation.
H335  May cause respiratory irritation
H360  May damage fertility or the unborn child.
Repr.  Reproductive toxicity
Skin Irrit.  Skin irritation

HMIS Classification
Health hazard:  2
Chronic Health Hazard:  *
Flammability:  2
Physical Hazard:  0

NFPA Rating
Health hazard:  2
Fire Hazard:  2
Reactivity Hazard:  0
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