Product Safety Assessment

CYCLOTENE™ Advanced Electronics Resin

Product Safety Assessments are available at: www.dow.com/productsafety/finder/.

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Names

- 1,3,5-Trimethylbenzene (CAS 108-67-8)
- AD-BCB
- B-staged Benzocyclobutene acrylic acid/Divinylsiloxane-bis-benzocyclobutene (CAS 404964-61-0)
- B-Staged divinylsiloxane-Bis-benzoCycloButene resin (CAS 124221-30-3)
- CYCLOTENE™ Advanced Electronics resin
- Dipropylene Glycol Dimethyl Ether
- DOWANOL™ PMA (CAS 108-65-6)
- Methoxybenzene (CAS 100-66-3)
- PROGLYDE™ DMM (CAS 111109077-4)
- Propylene Glycol Methyl Ether Acetate (PGMEA)

Product Overview

- Unless otherwise noted in this document, the information cited is for CYCLOTENE™ resin formulations that contain solvent, rather than the cured resins or films, the inert solid layer that remains after the solvents have been removed through curing and fabrication processes.
- CYCLOTENE resin formulations are yellow to red liquids with an aromatic odor.¹ When cured, these polymer films have low dielectric constants (low-k), meaning they will insulate against electrical current loss and electrical field interference. Lower dielectric constants indicate better insulation. For further details, see Product Description.
- CYCLOTENE resins are industrial products used in the microelectronics industry. These resins are mainly used as coatings for microchips (wafers made of silicon, ceramic, or laminate). These microchips may be used in cell phones, cars, computers, cameras, music devices, appliances, and other electronics. ² For further details, see Product Uses.
- Occupational exposure to CYCLOTENE formulations is possible in our resin manufacturing facilities, and also in facilities where the formulations are used for the production of microelectronics. Consumer exposure to uncured resins is very unlikely. For further details, see Exposure Potential.

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²™ Trademark of the Dow Chemical Company (“Dow”) or an affiliated company of Dow
The hazards associated with the handling of CYCLOTENE™ resin formulations are documented in Safety Data Sheets. Health hazards associated with individual CYCLOTENE resins may vary due to differences among the formulations and uses of the materials.

Manufacture of Product

- **Location** – Dow manufactures CYCLOTENE™ Advanced Electronics resin at facilities in the United States and Japan.
- **Process** – CYCLOTENE formulations are manufactured using proprietary Dow technology.

Product Description

CYCLOTENE™ Advanced Electronics resin manufactured by Dow are derived from B-staged bisbenzocyclobutene (BCB) chemistry. CYCLOTENE resin formulations are specialty polymer solutions that have been designed specifically for use in microelectronics production processes. They are formulated as high-solids, low-viscosity solutions.

CYCLOTENE resin formulations are yellow to red liquids with an aromatic odor. When cured, these polymer films have low dielectric constants (low-κ), meaning they will insulate against electrical current loss and electrical field interference. Lower dielectric constants indicate better insulation. Cured CYCLOTENE films are thermally stable up to 350ºC. They also have excellent chemical resistance. Other key properties include rapid thermal curing, low water absorption, and compatibility with copper.

The CYCLOTENE 3000 series are dry etch polymers. The CYCLOTENE 4000 series resins are negative toned photosensitive resins and the CYCLOTENE 6000 series are positive toned photosensitive resins. Both can be imaged using I-line, G-line and broadband radiation. Cured (or hardened) CYCLOTENE films range in thickness from approximately 1 to 30 micrometers (µm).

Product Uses

CYCLOTENE™ resins are industrial products used in the microelectronics industry, mainly as coatings for microchips (wafers made of silicon, ceramic, or laminate). When cured, they provide dielectric isolation, acting as an insulator between electric fields. Cured CYCLOTENE films are an effective barrier to copper electromigration. Cured CYCLOTENE films protect the circuitry from moisture damage, and are used as an adhesive for wafer-to-wafer bonding.

Another key application of CYCLOTENE is planarization, or surface leveling, of TFT flat panel display plates used in laptop computer screens.

CYCLOTENE resins are proven in a wide range of commercial applications:

- **Wafer-level, chip-scale packaging (WLP)**
- **Multilayer interconnects** – for dielectric isolation of copper (Cu) or aluminum (Al) multilayer interconnects built on silicon, ceramic, or laminate substrates
- **Micro Electro Mechanical Systems (MEMS) and 3-D integration** – as an adhesive to bond multiple wafers for 3-D integration
- **Printed circuit board technology** – as a dielectric matrix for high-density chip carriers/daughter boards and high-frequency telecommunications devices
- **Integrated passives and Radio Frequency (RF) components** – for dielectric isolation and as a secondary barrier to ionics and moisture

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Active matrix liquid crystal displays (LCDs) – to planarize Thin Film Transistor (TFT) flat-panel display plates, resulting in larger viewing angle displays and lower power operation

Passivation and stress buffer – as a protective layer on silicon, gallium arsenide, and ceramic devices

Gallium-arsenic interlayer devices (GaAs ILDs) – for interconnect on GaAs devices due to its excellent planarization characteristics

Exposure Potential

CYCLOTENE™ advanced electronic resins are used in the production of industrial and consumer products. Based on these uses, the following exposures are possible:

Workplace exposure – CYCLOTENE formulations are manufactured in closed systems using engineering controls which prevent the escape of liquid or vapors and minimize release to the environment. Chance of exposure is further reduced through the use of personal protective equipment. Occupational exposure is possible at microelectronics production facilities. Facilities that manufacture or use CYCLOTENE formulations should have a thorough training program for employees, appropriate work processes, and safety equipment in place to limit unnecessary exposure. See Health Information.

Consumer exposure to CYCLOTENE resins – Liquid CYCLOTENE formulations are sold for industrial use only, so consumer exposure to uncured resins is unlikely. Because microchip technology is widespread, consumers may use products containing these resins. When present in consumer electronics, CYCLOTENE resins are cured (fully polymerized as a result of the materials thermally reacting during the production process). The curing process creates a polymer solid which is encased in the electronic device. See Health Information.

Environmental releases – In the event of a spill, the focus is on containing the spill to prevent contamination of soil, ditches, sewers, waterways, and groundwater. For small spills, absorb with sand or sawdust. Collect in suitable and properly labeled containers. See Environmental, Health, and Physical Hazard Information.

Large release – Industrial spills or releases are infrequent and generally contained. Large releases are only possible in Dow's manufacturing facility where bulk equipment is in use. CYCLOTENE formulations are packaged in containers under 10-liters; therefore, only small spills are possible for our industrial users. If a large spill does occur, isolate area. Dike area to contain and prevent from entering sewers. Spilled resin formulation may create a vapor explosion hazard. Evacuate personnel to a location upwind and out of low-lying areas where vapor can accumulate. Only trained and properly protected personnel must be involved in clean-up operations. Ventilate area of spill. Eliminate all sources of ignition. Pump with explosion-proof equipment. If available, use foam to smother or suppress. Pump into suitable and properly labeled containers. Use appropriate safety equipment.

In case of fire – Isolate fire and deny unnecessary entry. Wear positive-pressure self-contained breathing apparatus and protective fire fighting clothing, or fight fire from a safe distance upwind. Use water fog or line spray, dry chemical or carbon dioxide fire extinguishers, or foam. General purpose synthetic foams or protein foams are preferred if available. Do not use a direct water stream, it may spread the fire. Fire water runoff, if not contained, may cause environmental damage. See Environmental, Health, and Physical Hazard Information.

For more information, see the relevant Safety Data Sheet.

For more information, see the relevant Safety Data Sheet.
Health Information
Health information about CYCLOTENE™ formulations is summarized in our Safety Data Sheets.

Environmental Information
CYCLOTENE™ Advanced Electronics resin formulations are blends of the following compounds (not all compounds are present in each product):

- B-Staged divinylsiloxane-benzocyclobutene resin
- Dipropyleneeglycol dimethylether
- Epoxy resins
- Propyleneglycol monomethylether acetate
- Methoxybenzene (anisole)
- Quinoline, 1,2-dihydro-2,2,4-trimethyl-, polymers
- Siloxane adhesion promoters
- 1,1′-(1-Methylethylidene)bis(4-(4-azidophenoxy)benzene)
- 1,3,5-Trimethylbenzene (mesitylene)
- 2-methoxy-1-methylethylacetate
- 2,6-Bis((4-azidophenyl)methylene)-4-ethylcyclohexanone
- Proprietary specialty polymers
- Proprietary photo-activators

For specific information on the environmental properties of disclosed components, please refer to the Safety Data Sheets of the product.

Physical Hazard Information
CYCLOTENE™ formulations are either flammable or combustible in liquid and vapor form. Solvent vapors present an explosion hazard. These are heavier than air, may therefore travel over long distances and accumulate in low-lying areas. Ignition sources should be avoided, and handling equipment should be electronically grounded.

Components in CYCLOTENE products can become reactive at temperatures above 100°C (212°F). CYCLOTENE products are incompatible with strong oxidizers.

CYCLOTENE products generally must be stored at temperatures below 40°C.

CYCLOTENE 4000 and 6000 series of formulations are photosensitive; they should be protected from sunlight and other sources of UV light. CYCLOTENE photosensitive formulations must be stored at temperatures below (-15°C). Exposure to higher temperatures can cause the photosensitive components in the products to decompose.

For more information, see the relevant Safety Data Sheet.

Regulatory Information
Regulations may exist that govern the manufacture, sale, transportation, use, and/or disposal of CYCLOTENE™ resin formulations. These regulations may vary by city, state, country, or
geographic region. Information may be found by consulting the relevant Safety Data Sheet, or Contact Us.

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Additional Information

- Safety Data Sheet (http://www.dow.com/webapps/msds/msdssearch.aspx)
- Contact Us: (http://www.dow.com/cyclotene/contact/index.htm)
- Product Literature for CYCLOTENE™ Advanced Electronics Resins (http://www.dow.com/cyclotene/resource/prodlit.htm)


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References

1 CYCLOTENE™ 4026-46 Advanced Electronics Resin Material Safety Data Sheet, The Dow Chemical Company, ID No. 50810/1001
2 Dow’s CYCLOTENE™ advanced electronics resins website (http://www.dow.com/cyclotene/app/index.htm).

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Form No. 233-00532-MM-0115X