MATERIAL SAFETY DATA SHEET [USA] / SAFETY DATA SHEET [EU]

Section 1. Product and Company Identification Date: November 15, 2008

Product Name: Thin-film Photovoltaic Copper Indium Gallium DiSelenide Solar String or Cell
Trade Names: G2 Thin Film String™ or Generation2™ Single Cell
Part Number: FG-18L
Product (Product) Use: This photovoltaic product is used in the manufacture of portable solar chargers, solar glass modules, and other solar equipment. The product converts solar energy into electrical energy.
Manufacturer: Global Solar Energy, Inc.
Manufacturer Address: 8500 South Rita Road, Tucson, Arizona, 85747 [USA]
Manufacturer Contact: Phone (01) (520) 546-6313* [USA]; Fax (01) (520) 546-6318 [USA]; email info@globalsolar.com

Section 2. Hazard Identification

Emergency Overview:
G2 Thin Film String™ and Generation2™ Single cell products are thin sheets of lightweight, flexible stainless steel substrate with **layers of metals deposited on the surface of the substrate**. The product may be packaged as a single cell or in strings (multiple cells) based on down line manufacturer need. **Cadmium sulfide dust and other metal contaminants may be deposited on the surface of the product as a by-product of manufacture**. The contaminant appears as a yellow powder.

The metal dust deposits on this product are considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200). Avoid dislodging deposits on surface of the product. Anticipated potential routes of entry include inhalation and skin/eye contact during aggressive handling, machining, manipulation and inadvertent ingestion if hands are not washed prior to eating, drinking or smoking following handling.

Potential Health Effects: Cadmium Sulfide: Irritant to skin and eyes. Toxic to kidneys, lungs, and liver. Classified as A2 (Suspected Human Carcinogen) by ACGIH; Classified as Group 1, *carcinogenic to humans* by IARC; and Group 1 (known carcinogen) by NTP.

Cadmium compounds are very toxic to aquatic organisms. The product must be disposed of as a hazardous waste in accordance with all federal, state and local regulations.

Section 3. Composition/Information on Ingredients in Product

CHEMICAL NAME	CAS #	EINECS #	EU CLASSIFICATION RISK (R)/SAFETY (S) PHRASES [1]	% (weight)
Aluminum zinc oxide	1344-28-1	215-691-6	N.E.	0.1%
Cadmium sulfide (sulphide)	1306-23-6	215-147-8	R22-40-48/23/25;S(1/2)22-36/37-45	0.1%
Copper	7440-50-8	231-159-6	N.E.	20 - 40%
Gallium	7440-55-3	231-163-8	N.E.	1 - 4%
Indium	7440-74-6	231-180-0	N.E.	1 - 4%
Indium tin oxide	1312-43-2 18282-10-5	215-193-9 242-159-0	N.E.	<0.5%
Molybdenum	7439-98-7	231-107-2	N.E.	0.75 - 3%
Polymer of Epichlorohydrin polyglycol, bisphenol A, and amino ether/fatty acids	26142-30-3 25085-99-8 68541-13-9	N.E. N.E. N.E.		<1%
Selenium	7782-49-2	231-957-4	N.E.	1 - 4%
Silver	7440-22-4	231-131-3	N.E.	<5%
Stainless steel; major components - Chromium III/VI - Manganese - Iron - Nickel	Various 7440-47-3 7439-96-5 7439-89-6 7440-02-0	Various 231-157-5 231-105-1 231-096-4 231-111-4	 R49-43-50/53; S53-45-60-61 N.E. N.E. R40-43; S(2-)22-36	50 - 70%
Tin	7440-31-5	231-141-8	N.E.	2 – 5%

[1] Section 15 provides the full text for each risk (R) and safety (S) phrase cited.
N.E. – Not Established

Section 4. First Aid Measures

General Advice: Normal hygiene practices should be observed when handling this product to include washing following handling and before eating, drinking, and/or smoking. In the event of exposure, consult a physician. Show this safety data sheet to the doctor in attendance.

Inhalation: If surface dust is inhaled, remove to fresh air. Consult a physician.

Skin and/or Eye Contact: In case of skin contact with metal dust flush with copious amounts of water for at least 15 minutes. Remove contaminated clothing and shoes. In case of eye contact with dust flush with copious amounts of water for at least 15 minutes. Assure adequate flushing by separating eyelids with fingers. Consult a physician.

Ingestion: If metal dusts are swallowed, wash out mouth with water. Consult a physician.

Section 5. Fire Fighting Measures

Release of heavy metals, heavy metal oxides, adhesive polymers and their combustion by-products may occur when burned.

If material is heated to decomposition, it will emit highly toxic fumes and dusts. Material will emit highly toxic fumes in contact with strong acids or oxidizers.

Fire fighting universally requires full respiratory protection (SCBA) and full fire fighting turnout gear (Bunker gear) to protect the wearer from a variety of hazards during a fire.

If product is involved in a fire, use water fog or spray, dry chemical extinguishing agents or sand.

Section 6. Accidental Release Measures

Avoid inhalation, ingestion or skin/eye contact with any dislodged dust.

Wash thoroughly after handling and before eating, drinking and/or smoking.

For disposal considerations, see Section 13.

Section 7. Handling and Storage

Avoid aggressive handling.

Avoid dislodging metal deposits (dust) on surface of the product.

Minimize dust generation and accumulation. Routine HEPA-vacuuming of storage and production areas is recommended to reduce accumulated metal dusts.

Avoid inhalation, ingestion or skin/eye contact with any dislodged dust.

Wash thoroughly after handling and before eating, drinking and/or smoking.

Store in a clean, dry location away from acids, acid vapors and oxidizers.

This product is intended to be used as shipped in the manufacture of solar cell equipment.

Section 8. Exposure Controls/Personal Protection

	OSHA		ACGIH		IOELV	
Component	TWA	STEL	TWA	STEL	TWA	STEL
Aluminum zinc oxide	5 mg/m^3 (as ZnO_2)	N.E.	2 mg/m^3 (as ZnO_2)	10 mg/m^3 (as ZnO_2)	N.E.	N.E.
Cadmium sulfide (sulphide)	0.005 mg/m^3	N.E.	0.002 mg/m^3	N.E.	N.E.	N.E.
Chromium (III)	0.5 mg/m^3	N.E.	0.5 mg/m^3	N.E.	2.0 mg/m^3	N.E.
Chromium VI (in stainless steel)	0.005 mg/m^3 (CrVI)	N.E.	0.01 mg/m^3 (CrVI)	N.E.	N.E.	N.E.
Copper	1 mg/m^3	N.E.	1 mg/m^3	N.E.	N.E.	N.E.
Gallium	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
Indium	N.E.	N.E.	0.1 mg/m^3	N.E.	N.E.	N.E.
Indium tin oxide	N.E.	N.E.	0.1 mg/m^3 (as In)	N.E.	N.E.	N.E.
Iron	10 mg/m^3	N.E.	5 mg/m^3	N.E.	N.E.	N.E.
Manganese	5 mg/m^3 (C)	N.E.	0.2 mg/m^3	N.E.	N.E.	N.E.
Molybdenum	15 mg/m^3	N.E.	10 mg/m^3	N.E.	N.E.	N.E.
Nickel	1 mg/m^3	N.E.	1.5 mg/m^3	N.E.	N.E.	N.E.
Polymer of Epichlorohydrin polyglycol, bisphenol A, and amino ether/fatty acids	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
Selenium	0.2 mg/m^3	N.E.	0.2 mg/m^3	N.E.	N.E.	N.E.
Silver	0.01 mg/m^3	N.E.	0.1 mg/m^3	N.E.	0.01 mg/m^3	N.E.
Tin	2 mg/m^3	N.E.	2 mg/m^3	N.E.	N.E.	N.E.

(S) – Skin notation
(C) – Ceiling concentration
N.E. – Not Established

Administrative Controls: Good personal hygiene habits are recommended. These include no eating, drinking or smoking in the work area; washing the hands and face after leaving the work area and before eating, drinking, smoking, or using toilet facilities; and removing contaminated clothing and showering at the end of the workday.

Engineering Controls: Engineering controls or exhaust ventilation is recommended when cadmium sulfide dust or other metal dusts on the surface are dislodged due to handling and approach the action level for the substance. Wipe sampling and air monitoring is recommended as a verification technique. Suction cup vacuum handling systems should be equipped with an inline HEPA filter upstream of tubing and vacuum equipment to prevent contamination. Routine HEPA-vacuuming of storage and production areas is recommended to reduce accumulated metal dusts.

Personal Protective Equipment: Personal protective equipment is recommended if workplace exposure monitoring of both air and surfaces indicates potential for exposure due to handling. If required, coveralls (tyvek), gloves (latex, neoprene, or nitrile) and impervious goggles are recommended.

Section 9. Physical and Chemical Properties

Material is (normal conditions): Solid
Melting Point: 2,400-2,800 F (stainless steel); 1,796 F (cadmium sulfide)
Boiling Point: N/A
Solubility in Water: Insoluable in cold water (cadmium sulfide)
Specific gravity (H2O = 1): 4.82 (cadmium sulfide)
Appearance and color: Flexible sheet with yellow to brown metallic sheen, odorless
Vapor pressure (mm Hg): N/A
Vapor density (Air = 1) : >1.0 (cadmium sulfide)
Evaporation Rate: N/A

Section 10. Stability and Reactivity

Stability: Stable
Flammability: At adequate concentrations metal dusts are flammable.
Conditions to avoid: Aggressive handling (excessive shaking, scraping, etc.). Avoid heating to decomposition.
Incompatibility (materials to avoid): Avoid acids, acid fumes and strong oxidizing agents.
Hazardous decomposition or byproducts: Metals, metal fume, adhesive polymers and their combustion by-products may be liberated if heated or burned.
Hazardous polymerization: Will not occur.

Section 11. Toxicological Information

This section presents a basic overview of currently known toxicological properties of the chemical constituents listed in Section 3. The signs and symptoms identified in this section will occur only as a result of overexposure.

Aluminum.
Acute Effects: Acute effects are rare. Local contact dermatitis has been reported.

Chronic Effects: Aluminum may be associated with many neurodegerative disorders. Chronic exposure is associated with a lung disease, Shaver's disease, characterized by dyspnea, coughing, substernal pain, weakness, and fatigue.

Cadmium Compounds.
Acute Effects: May cause upper respiratory symptoms, including cough, throat discomfort, general malaise, shivering, sweating, body pains, and headache. In severe cases of acute exposure, pulmonary edema, bronchopneumonia, and a death may occur.

Chronic Effects: Mortality from non-malignant respiratory disease is highest among workers exposed to cadmium. However, the kidneys are the primary target organ affected by chronic exposure to cadmium compounds. Cadmium and its compounds are confirmed human carcinogens with significant exposure-related increases in lung cancer among cadmium workers. Cadmium is excreted very slowly; therefore, is considered to bioaccumulate.

Chromium (III and VI).
Acute Effects: Hexavalent chromium can cause severe irritation of exposed tissues. Acute effects are largely contact dermatitis and ulceration of the skin and exposed mucosa. Low-level exposure and can results in long-term sensitization. The trivalent form is poorly absorbed through inhalation and intact skin contact.

Chronic Effects: Long-term exposure to chromium may result in upper respiratory tract lesions ranging from nasal itching to septal ulceration and perforation. Occupational exposure via inhalation to the hexavalent form is considered to increase the risk of lung cancer significantly. There also have been reports of increased nasal, pharyngeal, and gastrointestinal carcinomas.

Copper.
Acute Effects: Acute toxicity is uncommon although dust and fume can be irritating to the skin, eyes, and respiratory tract and reports of general malaise and "stuffiness". Ingestion of copper has been linked to a metallic taste in the mouth, nausea, vomiting, epigastric burning and diarrhea.

Chronic Effects: Chronic illnesses are not reported with copper overexposure. Illnesses in copper industries have been linked to the presence of other harmful metals also found in the workplace. Copper has not been found to have any carcinogenic, teratogenic, or mutagenic properties.

Gallium and Indium.
Acute and Chronic Effects: Gallium and indium have similar toxicities. Gallium is poorly absorbed from the gastrointestinal tract. Gallium and indium toxicity is characterized by renal tubular injury. Inhalation of gallium and indium oxide causes alveolar proteinosis and fibrosis. Both gallium and indium can be teratogenic and embryocidal when given intravenously to animals.

Iron.
Acute and Chronic Effects: Exposure to iron dust and oxides may cause respiratory disease (siderosis).

Manganese.
Acute Effects: Exposure to dust and fumes may cause respiratory illness, higher rates of bronchitis, and increased susceptibility to infection. Inhalation of fumes of manganese and manganese oxide is associated with metal fume fever which includes symptoms of fever, chills, upset stomach, cough, weakness, body aches, headaches, vomiting, and dry throat.

Chronic Effects: Chronic exposure to manganese has been associated with central nervous system effects including Manganism, which is similar to Parkinson's disease and Hehnestritt.

Molybdenum.
Acute and Chronic Effects: Occupational overexposure to molybdenum is uncommon. Joint pains, backaches, and headaches were the most common acute medical complaints. Chronic exposure had been associated with gout, pneumoconiosis, and disruption of copper levels in the body.

Nickel.
Acute and Chronic Effects: Metallic nickel and nickel compounds may cause hypersensitivity resulting in nickel contact dermatitis, allergic rhinitis and triggering asthma. Nickel oxide is recognized as an animal and human carcinogen.

Selenium.
Acute Effects: Selenium dust can cause irritation of the skin, mucosa, and respiratory tract and garlic odor of breath, sweat, and urine. Selenium can cross the placenta and pass into breast milk.

Chronic Effects: Chronic exposure of selenium and deposition in tissues can produce a reddish hue in the hair, nails, teeth, eyes, and skin. Degenerative neurological syndromes have been reported in animals and humans with chronic intoxication. There is conflicting data about the role of selenium in mutagenesis and carcinogenesis. High levels of selenium cause teratogenesis in experimental animals and in poultry. Various selenium compounds are carcinogenic in animal studies. However, excess cancer risk from industrial and environmental exposure to selenium has not been demonstrated.

Silver.
Acute and Chronic Effects: Silver intoxication may cause the systemic distribution and deposition of silver-containing products in the body resulting in slate gray discoloration of the skin (argyria). May be irritating to the skin, eyes and mucosa.

Tin.
Acute and Chronic Effects: Metallic tin has low oral toxicity due to poor absorption. Inhalation of tin dust or tin oxides may produce benign pneumoconiosis (stannosis). Inorganic tin oxides may cause skin and eye irritation.

Zinc.
Acute and Chronic Effects: Metal fume fever can be caused by inhalation of zinc oxide fume. Large doses of zinc salts cause intense nausea, vomiting and diarrhea. Zinc chloride can cause burns to the skin, eyes, mucosa, and esophagus. Zinc metal is not teratogenic or carcinogenic unless in the form of zinc chromate.

Section 12. Ecological Information

Cadmium compounds are very toxic to aquatic organisms and may cause long-term adverse effects in the aquatic environment. See Section 13 for disposal requirements.

Section 13. Disposal Considerations

This product must be disposed of as a hazardous waste. Dispose of in accordance with all applicable federal, state and local regulations.

Section 14. Transport Information

As packaged, G2 Thin Film String™/Generation2™ Single Cell articles fall under the US Department of Transportation (DOT) Small Quantity Exception Rule [49 CFR 173.4 (a) and (a)(iii)] and are exempted from other shipping requirements of the subchapter.

Section 15. Regulatory Information

OSHA – 29 CFR 1910.1027, standard for *Cadmium* should be consulted when implementing recommendations in Section 8.

SARA Title III - this product contains cadmium (minimal surface contaminant) that is subject to SARA section 313 reports.

EU - A chemical safety assessment has not been carried out for this product.

Risk and Safety Phrases referenced in Section 3.

Glossary of Risk (R) and Safety (S) Phrases referenced in Section 3.

Risk (R) Phrases		Safety (S) Phrases	
R22	Harmful if swallowed	S1	Keep locked up
R23	Toxic by inhalation	S2	Keep out of the reach of children
R25	Toxic if swallowed	S22	Do not breathe dust
R37	Irritating to respiratory system	S36	Wear suitable protective clothing
R40	Possible risk of irreversible effects	S37	Wear suitable gloves
R43	May cause sensitization by skin contact	S45	In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible)
R48	Danger of serious damage to health by prolonged exposure	S53	Avoid exposure – obtain special instructions before use
R49	May cause cancer by inhalation	S60	This material and its container must be disposed of as a hazardous waste
R50	Very toxic to aquatic organisms	S61	Avoid release to the environment. Refer to special instructions/Safety data sheets
R53	May cause long-term adverse effects in the aquatic environment		

Section 16. Other Information

This product is intended to be used as packaged in the manufacture of solar cell equipment. Care should be taken when handling the solar cells to protect the cell from damage and to avoid liberating any metal dusts on the surface of the cells or strings. This product is encapsulated by the down line manufacturers during solar cell construction.

This Material Safety Data Sheet or Safety Data Sheet has been prepared under in accordance with 29 CFR 1910.1200 using the guidelines of ANSI Z400.1-2004 and EU Regulation No. 1907/2006, including Annex II (Guide to the Compilation of Safety Data Sheets). The unofficial consolidated list of Indicative Occupational Exposure Limit Values (IOELV) was referenced to provide occupational limits for the European Community (EU). It should be noted that, per source directive 98/24/EC, the IOELV's are currently being reviewed.

Surface wipe sampling has been collected by the manufacturer and is available upon request.

Limitations

This material safety data sheet/safety data sheet reflects our current knowledge and hazards associated with anticipated use of this product/article. It does not represent a guarantee of all hazardous properties of the product under all conditions of use. The user is responsible for ensuring compliance with all statutory provisions relating to health, safety and the environment.

DATE: November 15, 2008