



Torpedo Solar Overview

Experience

- Over 50 years in high precision, high performance wire products in Automotive, Electronics, Telecommunications, Lighting, Utility, Appliance, and Aerospace Markets
- Supplying PV ribbon products to large worldwide solar panel manufacturers since 1998.
- Technical team with decades of expertise in developing solutions to meet the most demanding industry requirements.
- Well positioned to significantly expand capacity to meet growing PV market volumes - quickly and effectively

Quality

- ISO 9001:2008 and ANSI/ISO/ASQ 9001-2008 Certification
- Robust, well-documented quality management system for every step in the manufacturing process
- Continuous monitoring and real-time SPC in place
- Proprietary equipment and processes which result in excellent control of forming consistency and extremely balanced coating

Value

- A broad array of products and excellent service at competitive prices
- Superior ribbon characteristics that ensure high performance in solderability, consistency, and long term reliability
- Wire is our business and our business only – we have the expertise and knowledge to meet your PV ribbon needs



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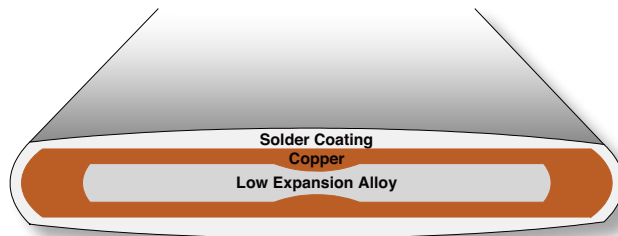


Copper PV Ribbon

PV Ribbon Wires are produced by rolling drawn round wire into flat wire. Torpedo products solve the problems of edge burrs and exposed copper edges exhibited by slit flat wire. Our products are level wound onto plastic spools to provide extra footage for longer cell production runs. Each order is made to specification: conductor type, dimension, solder type, solder thickness, physical properties, and electrical properties.

PV Ribbon Wires are produced utilizing special controlled heat treatments to provide different tempers depending on the customer's needs. A SuperSoft temper is available with special modified anneal performed prior to hot solder coating. The Supersoft tempered material helps reduce wafer fracturing during the connection process performed by solar module producers.

Low Expansion PV Ribbon



Torpedo Specialty Wire is pleased to introduce a new cell interconnect technology to the solar module industry-Low Expansion PV Ribbon Wire. This new low expansion material meets the same size tolerances as our copper products and is available in the same packages.



PEFC/29-31-120

PV Ribbon Technical Data

Uncoated substrates:

Description	Electrolytic Tough Pitch Copper	Oxygen Free Copper	Oxygen Free Electronic Copper	Low Expansion Bimetal
Copper Industry Designation	CD-110	CD-102	CD-101	N/A
UNS Designation	C110000	C102000	C 101000	N/A
Composition	99.9% Cu	99.95% Cu	99.99% Cu	Copper Clad Ni/Fe alloy core
Electrical Conductivity %IACS	101	101	101	69
Thermal Expansion $\mu\text{m}/(\text{m } ^\circ\text{C})$	17.3	17.3	17.3	8.4

Standard Bare Wire Range and Tolerances:

Description	Range and Tolerance mm	Range and Tolerance inch
Thickness	0,05-0,50 mm + 0,005	0.002 to 0.020 + 0.0002 inches
Width	0,76 to 7.6 mm + 2%	0.030 to 0.300 + 2%

Standard Solder Coating Types:

Description	Chemistry	Melting Point $^\circ\text{C}$
Tin Lead	60Sn/40Pb	183-188
Tin Lead	All ratios available	
Tin Lead Silver	62Sn/36Pb/2Ag	179
Tin	100%	232
Tin Silver	Sn96.5/Ag3.5	221
Tin Bismuth	42Sn/58Bi	138
Other alloys (or silver)	As Requested	

Standard Solder Coating Thickness Range:

	Microns	Microinches
Average Thickness	3-25	120-1000

Standard Tempers:

Description	0.2% Max Offset Yield N/mm ²	0.2% Max Offset Yield PSI	Elongation %
125	125	18,000	28
110	110	15,900	28
100	100	14,500	25
90	90	13,000	25

Please Contact TSW for special sizes, solders, coating thickness , or temper specifications.



History

The Company was founded in northwest Pennsylvania by Mr. Henry McConnell in 1959. First incorporated in 1966 in Torpedo, Pennsylvania, the company opened the Rocky Mount, NC facilities in 1975. Combined manufacturing facilities total 150,000 square feet. In 1997, the Company moved to new corporate headquarters in North Carolina. Since the mid-80's the company has been certified as a minority business enterprise. Principals in the closely held Company are Harold McConnell and Loren Ota.

Our Mission

Torpedo Specialty Wire's mission is to be recognized as the preferred, highest quality supplier on the planet for specialty wire products and services. We will:

- Manage and produce specialty wire with respect, honesty, and integrity
- Empower all our people to continuously improve
- Earn a reasonable return for all stakeholders
- Enjoy our efforts

Markets Served

Torpedo Specialty Wire products find global market applications. We supply domestic USA and export worldwide to meet the exacting requirements of diverse industries including:

- Photovoltaic Energy
- Wind Energy
- Electronic components
- Automotive
- Lighting
- Telecommunications
- Electrical Utility
- Appliances
- Aerospace and Defense

Corporate Quality Policy

The quality policy of Torpedo Specialty Wire is to delight all customers by meeting or exceeding their quality expectations and requirements. We will:

- Measure quality accurately
- Practice continuous improvement
- Minimize process variation
- Train people continuously

Quality Assurance

Operator self- inspection and internal quality assurance auditing are the backbone of our ISO 9001-2008 quality system. We are registered through Lloyd's Register Quality Assurance, Inc.

Core Processes

Cladding:

Bonding of copper strips to ferrous rods is a core competency at Torpedo Specialty Wire. Applications for copper clad wire include lead wire for electronic components, lighting, and ground wire for utilities and wind energy systems. Custom copper thicknesses and substrates are available.

Drawing:

Torpedo Specialty Wire's drawing equipment is capable of reducing copper and steel rods, nonferrous and ferrous alloy rods, and composite material rods, to diameters as fine as 0.007 inch. Wet drawing, lubricants and dry drawing lubricants using carbide, natural diamond, and man made diamond drawing dies may be used for special mechanical or cleanliness criteria.

Annealing:

Batch, resistance, and tube stand annealing heat treat options may be used to meet custom tempers and physical properties. Protective atmospheres are used to maintain bright, clean, oxide free heat-treated surfaces.

Electroplating:

Tin, solder, copper, and nickel coatings are electroplated on custom equipment designed and built by Torpedo. High speed, single strand, multi-pass processes are carefully controlled and monitored to meet customer specifications.

Torpedo Specialty Wire's Pennsylvania nickel plating facility represents one of the world's foremost continuous nickel electroplating plants. This focused factory is capable of high throughput and the ability to nickel plate a wide range of wire diameters, plating thicknesses, and substrates.

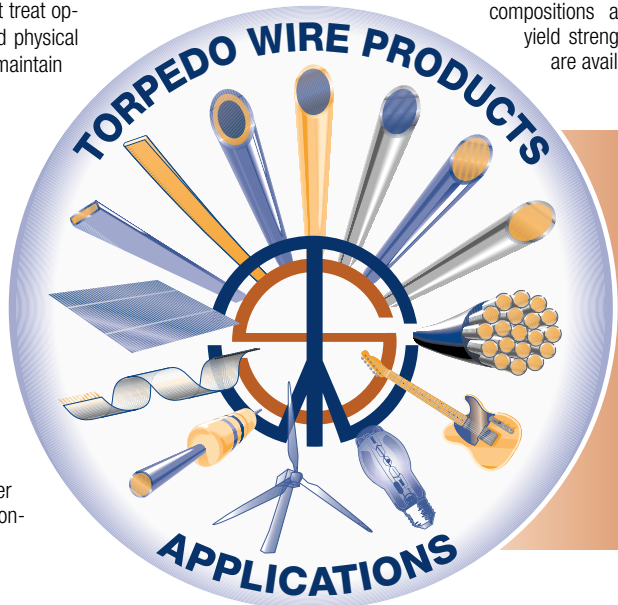
All electroplating operations are performed under State and Federal permits meeting stringent environmental regulations.

Flat Wire Rolling:

Torpedo Specialty Wire's proprietary design precision rolling mills produce only the highest quality flat wire. This machinery features in-line rolling and annealing technology, which permits tight tolerance production for hard and soft tempered copper and nonferrous alloy flat conductors. Our rolling lines incorporate state-of-the-art spooling technology, that supports continuous operation, and permits economic production of matched spool sets, as required in photovoltaic solar module and automotive flat cable applications. All rolling line processes are constantly monitored by laser gauging systems, which provide real time statistical process data, assuring minimal dimensional variation within our spools, and from lot to lot. Our rolled flat wires have rounded edges and no burrs.

Hot Tin Coating:

Torpedo Specialty Wire has developed a molten tin coating process and designs and builds the equipment to produce interconnect and buss wire for the photovoltaic solar module market. Precision flat copper wires are rolled, heat treated, and coated with thick solder coatings of pure tin, tin/lead, tin/silver, or tin/lead/silver alloys. All sides are hot dip coated with solder. Custom solder compositions and special low yield strength, soft tempers are available.



Your Reliable CONNECTION

Now and for the Future...

