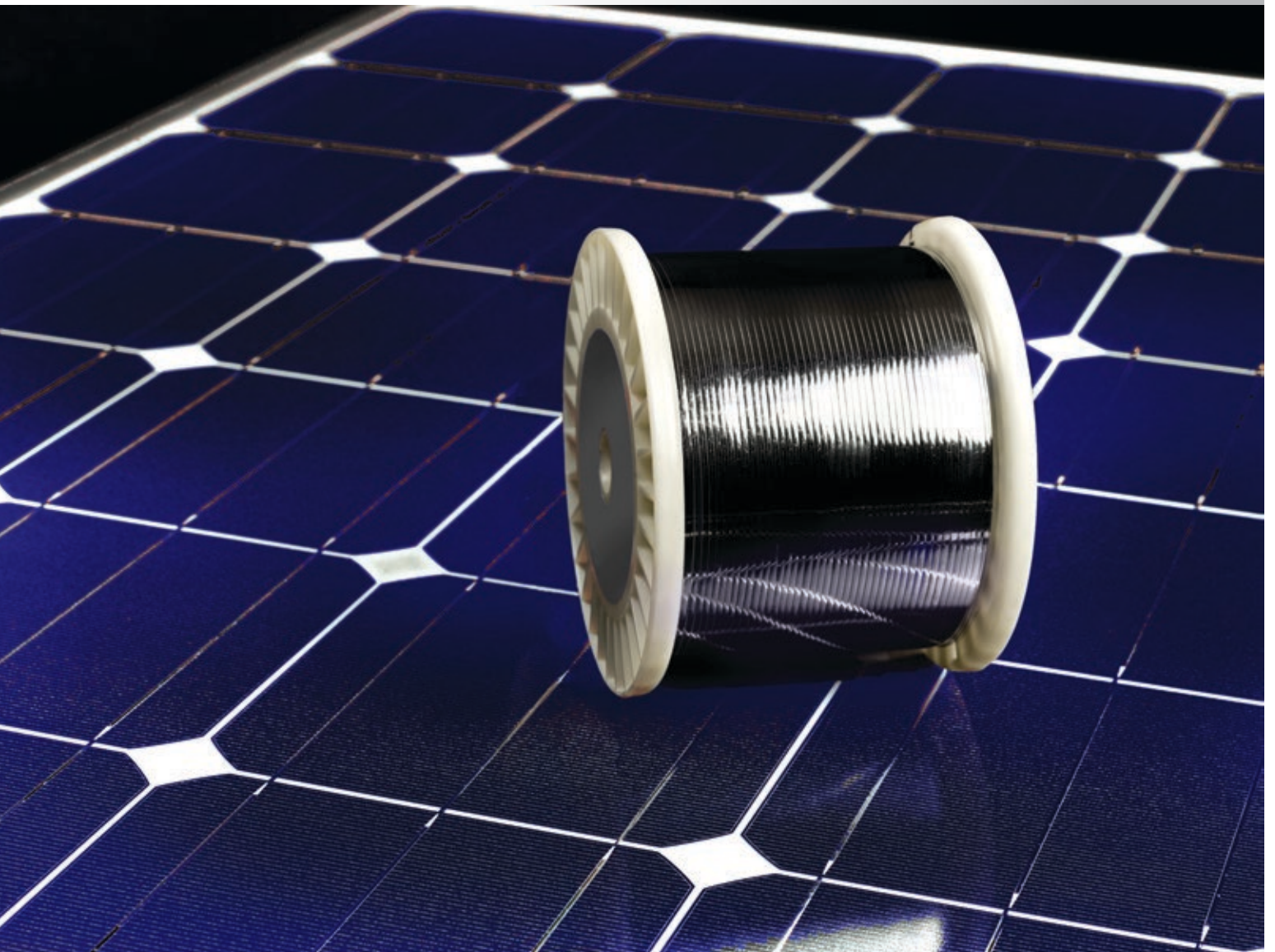




Solar Technologies

World Leaders In Photovoltaic Ribbon

WWW.PVRIBBON.COM



Diversity, Experience, Custom Made Orders

Tinned, Precision Copper Flat Ribbon for Solarcell Tabbing and String Interconnect

Diversity

With three state of the art production facilities worldwide, Ulbrich is a global leader in the supply of tinned precision copper flat wire for solarcell tabbing and string interconnect. With manufacturing facilities in the United States and Austria, you do not need to look any further for a partner to grow your PV business.

Ulbrich sales, technical staff, and material reach the world with customers in Africa, Asia, Europe, North America, South America and Oceania. Ulbrich enhances communication with our staff's ability to speak a broad range of languages: English, German, French, Italian, Japanese, Spanish, Mandarin and Cantonese. Ulbrich has the answers in your language, in your country.

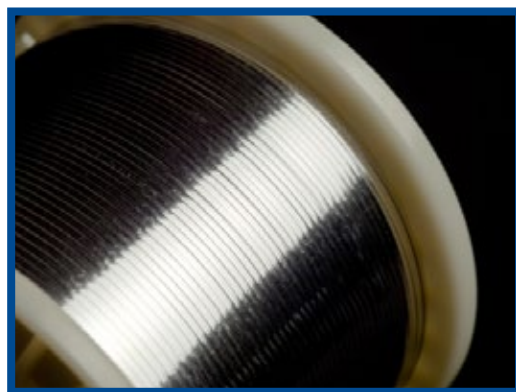
Experience and Focus

In an ever evolving market, Ulbrich has over 26 years experience supplying PV ribbon. You benefit from our experience and focus factory atmosphere. Our focus factory processes PV ribbon and only PV ribbon. This minimizes machine setups, inconsistent plating, long delivery schedules and minimum orders. This focus keeps Ulbrich and our customers at the forefront of PV ribbon technology.

Custom Made Orders

All orders are custom made to your specifications. All standard interconnect and bus bar ribbons have solder coating on all four sides. The plating is done after we roll the ribbon from round wire and burrs are nonexistent. Although ribbon represents a very small percent of the module cost, it is a vital component. Thus, Ulbrich is your source for the highest quality ribbon.

Do you require a specification? Please utilize our technical staff to assist you. Again, any size order, Ulbrich has the ability and capacity to grow with your business.



99.90% Copper Base Metal - UNS C11000 (CDA-110), UNS C10200 (CDA 102)



Hot Dip Tin Alloy - from 0.5 to 50 Microns per side

Engineering and Technical Staff Available to Assist with any PV Product Request

PV Interconnect Ribbon/Bus Wire

All interconnect and bus bar ribbons by Ulbrich Solar Technologies, Inc. have solder coating on all four sides since plating is done after the ribbon is rolled from round wire. Also, burrs are nonexistent in ribbon/bus wire rolled from round wire.

Base Metal Options

UNS Designation	Common Name	Copper Content	Resistivity (ohm gram/m ²) (Annealed) @ 20C
C10200	CDA102 Cu-OF1	99.95%	0.15176 Max.
C11000	CDA110 Cu-ETP1	99.90%	0.15328 Max.

Contact Ulbrich Representatives for temper designation.

Solder Coating Options

Lead Free	Leaded	Coating Thickness
96.5Sn/3.5Ag	60Sn/40Pb	20 to 2000 microinches
100Sn	62Sn/36Pb/2Ag	(0.5 to 50 microns)

Other solder alloys available on request.

Base Material

Base Metal Thickness	Base Metal Width	Camber	Yield	Elongation
0.025 - 0.5mm +/- 0.008mm	0.8 - 12mm +/- 0.08mm	Max 8mm/m	Max 65N/mm ²	25% min

Certification and Labeling

A Certification of Compliance and Certified Test Report is provided with each shipment and includes:

Customer Order Number	Customer Name	Date and Ulbrich Number	Customer Part Number
Specification/Revision Level	Description of Product	Size	Quantity
Tensile/Yield Strengths	% Elongation	Coating Thickness	Grain Size (if required)
*Complete Chemical Analysis	*Copper Content	*Package Bar Code Labeling	*Data Matrix Code Label

Note: * Available upon request.

Spool information includes:

Part Number	Job Number	Size	Solder Alloy
Material Weight	Date	Spool Number	Operator Initials

Warranty

Ulbrich Solar Technologies, Inc. guarantees and warrants our product to your application.

Interconnect Wire

Engineered for Thinner Solar Cells

Thinner Solar Cells require the lowest possible yield strength on interconnect ribbon. The values of our PV Ribbon are lower than 65 N/mm² yield strength and more than 25% elongation at fracture. Not easy to achieve - but possible with Ulbrich!

Tabbing Ribbon XP

Standard Specification

Tensile Strength RM [N/mm ²]	Yield Strength Rp0.2 [N/mm ²]	Elongation at Rupture A100 [%]
Max. 270	Max. 65	Min. 25

Base Metal Options

CDA 110	Cu-ETP1	CDA 101	CDA 102
Cu-0F1	Copper Alloys	Aluminum Alloys	Hybrids

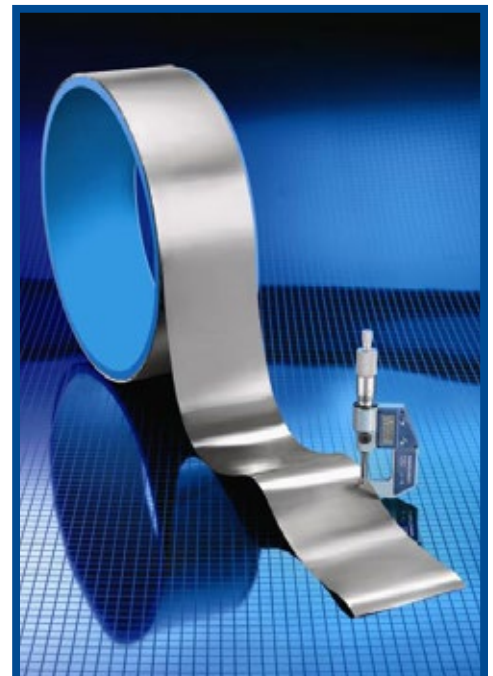
Thin Film

Conductor Foils

- Ulbrich has extensive capabilities and scientific resources to achieve the optimum conductive solutions for thin film modules.
- Thicknesses down to 0.025mm
- Widths up to 25.4mm
- Tinned copper, silver plated copper, aluminum alloys and hybrids.

Metal Substrate

- Surface Morphology down to 250 Angstroms.
- Surface Cleanliness - Oil and defect free for your thin film module requirements.
- Tolerances - Closer than Commercial Dimensional Width.
- Gauges starting at 10 microns
- Alloys including: Stainless 300 and 400 series, Precipitation hardened stainless,
- Nickel, Cobalt, and Titanium.
- Flatness - Ultra Flat - No ripples - No buckles - No creases - No edge waves.
- Availability - Most diversified inventory with process flexibility in the industry.
- Delivery - Shortest lead-times in the Industry and excellent on time performance.
- Technical and Metallurgical support from Ulbrich's Metallurgical Staff.



L-Shaped Bus Ribbon

A New Forming Technology for Solar Ribbon

Precision Forming

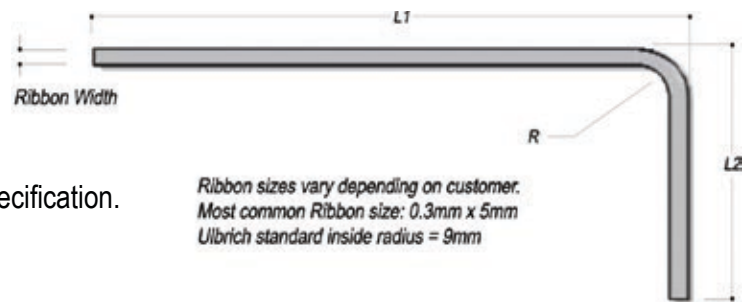
Rolled and coated ribbon is bent 90 degrees to form an L-shape. Ulbrich's L-Shaped Bus Ribbon increases solar production by offering customers a pre-formed, ready to install solar ribbon.

Pre-Formed Solar Ribbon

- Currently accepting orders for the new L-shaped bus ribbon.
- Additional shapes under development.
- Ulbrich will design and manufacture to meet the customer's specification.
- Custom packaging available.

90 Degree Bend Radius

Ulbrich's L-Shaped Bus Ribbon is formed with a high quality, precise bend that results in a smooth curve free of wrinkles and other unwanted deformations.



I-Shaped Bus Ribbon

- Length 60mm - 600mm.
- Length tolerance (+/- 1.0mm).
- Custom packaging - Shipped in sturdy plastic tubes.
- Can produce I Bus along with your L Bus and interconnect wires all in one.
- Coating type and thickness made to specification.



Bus Bar

Ulbrich Solar Bus Wire is primarily produced from a tin or tin alloy coated copper flat wire, and is rolled from round wire, then solder coated on all four sides. This combination of processes results in superior coatings and a completely burr free product. Our PV Ribbon products are produced from the highest quality material, with each order engineered to your dimensional and physical property specifications.

Bus Wire - Continuous Coil

- Solar Bus Wire available on all standard spools or ribbon wound coils.
- Lead or Lead free solders applied on all four sides for consistent bonding with tabbing ribbon.
- Consistent surface finish.



Light-Capturing Ribbon (LCR-XP™)

Extra High Efficiency Solar Interconnect Wire

LCR-XP™ is a high efficiency grooved solar cell interconnect wire that replaces traditional flat ribbon used to connect solar cells together within a module. It was developed to increase the efficiency of a solar module by reflecting more light back onto the surface of the cell. This innovative grooved interconnect wire steers the reflected light back to the glass/air interface allowing total internal reflection back onto the cell surface.

Up to 4% Increase in Solar Module Power Output*

- Up to 80% of the incoming light that strikes the LCR-XP™ ribbon is recovered significantly higher than the 5% recovery of traditional solar cell tabbing and interconnect wire. Increased efficiencies also mean less modules, land, transportation and other BOS costs.
- Increase in output from wire grooved shape as well as wire thickness and width optimization

*Note: * Actual power output can vary depending on design and ribbon cross section optimization.*

Transition to Larger, Thinner Solar Cells

LCR-XP™ Wire can be made in varying cross sections to reduce resistive losses, maximizing current output, without compromising module efficiency.

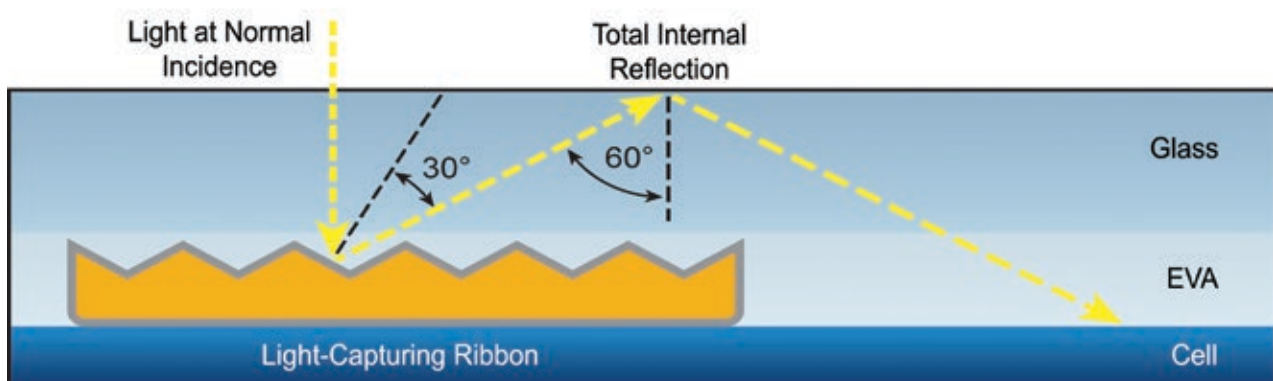
Compatible with Your Current Stringer Equipment

LCR-XP™ Ribbon offers multiple application methods that can be adapted to your current tabber-stringer equipment.

- Conductive Pastes
- Conductive Adhesives
- Conductive Films
- Soldering

Improved Module Appearance

The new solar cell modules using the LCR-XP™ Ribbon are uniformly dark because most of the light striking the cell is captured. This sleek, dark appearance makes them the primary choice in improving architectural aesthetics. They are easily recognized and distinguished from the standard products and have a higher customer appeal.



Schematic drawing of light hitting the Light-Capturing Ribbon, being reflected back onto the cell

LCR-XP™ Data Sheet

Features

- Premium high performance line of Light Capturing Ribbon
- Electro-Plated Silver over a copper base ribbon with light capturing profile geometry for maximum reflectivity and conductivity
- Engineered lower yield strength copper wire to prevent cell damage during stringing process
- Now also available in Bare Copper and Solder Coated Copper
- Application Engineers design LCR products to satisfy each clients' unique needs and specifications
- Low Coefficient of thermal expansion (low yield) for minimal internal stress (day/night effect) prevents cell breakage during extreme temperature changes and variations.

Silver Coating	99.99% Purity Electro-Plated from round wire to ensure consistent plating on all sides
Sizes Available	Thickness Range: 0.12mm - 0.35mm (+/- 0.008mm) Width Range: 1.00mm - 6.00mm (+/- 0.08mm)
Physical Properties	Yield Strength: 65 N/mm ² max Reduced Silver % Elongation > 25%
Copper Base Material	ASTM Standard Copper: CDA 110 and CDA 102
Reflectivity	65% Minimum and up to 85% potential Measured using Ulbrich reflectivity gage Measurements taken from the total ribbon grooved surface Up to 4% Power Gain through reflectivity and ribbon cross section optimization



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Ulbrich Solar Technologies, Inc. is a private company and has the same owners as Ulbrich Stainless Steels and Special Metals, Inc. Established in 1924 and now one of the worlds leading processors of specialty metals. Manufacturing on three continents with a global sales and technical staff.