

Rolled Foils in Batteries

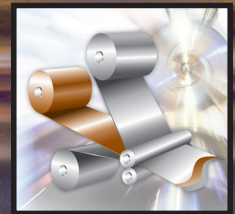
Product Information



Rolled Copper and Nickel Foils



High Tensile Alloy Foils



Roll-Clad Copper Foils



For nearly 100 years SCHLENK has specialized in the manufacturing of the thinnest rolled (RA) metal foils with a wide variety of possible surface finishes and supply formats. SCHLENK has supplied copper and nickel foils to the battery industry for over three decades.

Using Foils in Batteries ...

... as current collector

- Ultra-thin copper, nickel and silver foils
- Enhanced mechanical strength and thermal stability
- Optional roll-clad surface based on tin, aluminum or silver
- Optional ultra-smooth surface

... for tabbing

- Thin copper, nickel or roll-clad strip
- Slit to narrow width

... for flex harness - cell connection based on flexible printed circuit board (FPC) technology

- Thin copper and nickel
- Lamination quality

... for wiring the battery system - based on flexible flat cables (FFC)

- Thin copper
- Slit to narrow width

Battery Sample Kit

For the increasing market of energy storage systems, SCHLENK introduced the Battery Sample Kit to support R&D work. Please reach out to battery@schlenk.com for more information on the available sample materials. For detailed specification see separate stock list.



Differences of ED and RA copper foils

	Standard ED Foil	Standard RA Foil	High Tensile Foil - HTA
Thickness	Typically 4.5 - 10 µm	6 - 500 µm	8 - 500 µm (6µm in R&D)
Maximum width	Up to 1200 mm possible	Max. 660 mm	Max. 660 mm
Surfaces	Two different sides (1x rough, 1x plain)	Homogeneous, plain (ultra-smooth possible)	Homogeneous, plain (ultra-smooth possible)
Available alloys	Not possible, only pure metals can be deposited	Nearly no limitations	
Ultimate tensile stability	Max. 400 MPa	> 360 MPa, typically 400 - 450 MPa	Up to 750 MPa possible (depending on alloy)
Temperature stability	UTS stable up to 180° C	UTS stable up to 250° C	UTS stable up to 300-500° C (depending on alloy)
Tin-/Al-cladding	Not possible	Available	Available

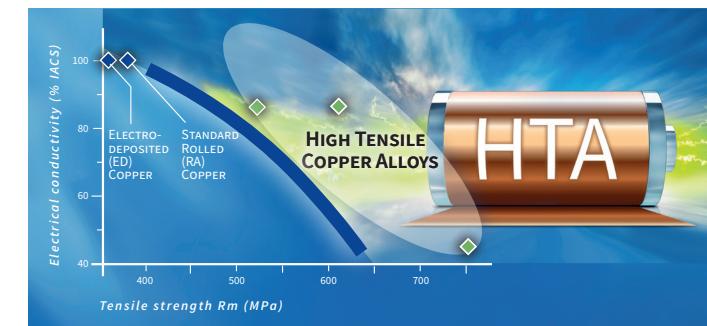
ED copper foil is electrodeposited on rotating drums. The manufacturing process of **rolled copper foil (RA)** where copper is cast in large blocks and rolled to thickness is somewhat more complex but enables the implementation of unique properties in rolled foils.

Due to the casting process virtually any alloy can be rolled to thickness. This allows the use of special copper alloys with high tensile strength and superior thermal stability.

The rolling process provides a fairly smooth finish that is equal on both sides. Ultra-smooth roughnesses can be achieved by special processing. Optional coatings with Sn, Al and other metals can also be applied based on the unique roll-clad technology.

Those special properties make rolled foils more robust and an ideal substrate for next-generation battery technologies.

Rolled copper foil is used in applications with challenging requirements



SCHLENK has developed thin rolled (RA) copper foils based on **High Tensile Alloys**. Used as a current collector foil in silicon-based anodes, the mechanical strength of these foils (up to 750 MPa compared with approx. 300 MPa of pure copper) helps to address the volumetric expansion of Si.

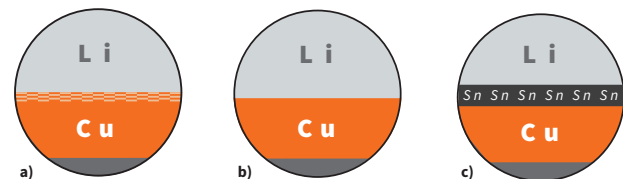
The High Tensile Alloys also provide excellent thermal stability when exposed to temperatures in the range of up to 500°C that can be reached in special coating processes. The increase in mechanical strength and temperature stability comes at the expense of a reduced electrical conductivity.

Please visit our battery website or download our flyers.

Foils for Future Battery Generations

Another path to increase the energy density in batteries are **solid-state batteries (SSB)**. Recent developments focus on **lithium metal anodes** that are pre-lithiated by electroplating, lamination or other coating process. A novel approach are anode-free designs where Li is deposited during the first cycle. Dendrite formation between Cu and Li seems to be a major obstacle.

A protection layer on the copper foil based on tin or other metals may help to suppress dendrites and support adhesion. SCHLENK offers such ultra-thin and precise coatings based on tin, aluminum or silver with its roll-clad technology.



a) Plain and degreased surface

Different degreasing finishes with improved residual oil levels can be offered.

b) Ultra-smooth surface

The very low roughness has proven to support CVD processes.

c) Tin-coated surface

A thin protection layer based on Sn or SnAg prevents a direct contact between the Li and Cu. Sn has a relatively low reactivity compared to Cu.

Bipolar electrodes

The bipolar battery design reduces complexity, avoids inactive components and reduces production costs. SCHLENK offers thinnest Al-Cu clad foils, a composite foil made of aluminum and copper.

Ultra smooth copper and nickel foils

Applications based on special coating processes (i.e. **chemical vapor deposition – CVD**) may require extremely smooth surfaces for optimal deposition results.

SCHLENK can produce foils with a surface roughness below 50nm Ra on both sides. These ultra-smooth copper and nickel foils provide good adhesion of coatings applied by CVD processes. The extremely clean and smooth surfaces are also suitable for high-quality monolayer and multi-layer **graphene** growth and are available in different form factors (in customized rolls and sheets) as substrate material.



Competencies



Rolling:
Wide, ultra-thin, different materials



Slitting:
Narrow, thin, precise



Surface upgrades:
Degreasing, roll caldding (single or double-sided), ultra-smooth

Materials

- Copper, Silver, Nickel and their alloys
- Thickness: 0.006 mm – 0.400 mm
- Width: 0.6 mm – 650 mm

Forms of delivery

- Coils on different core sizes
- Sheets
- Etched / stamped parts

Individually tailored deliveries

- Small lots for R&D
- Large lots for mass production
- Extended services

Summary

- RA foils made from high purity copper grades
- Different alloys available with distinct features
- Available for testing with SCHLENK Battery Sample Kit
- Optional coating on one or both sides available
- Experienced application engineering team
- Well equipped laboratories including Scanning Electron Microscope (SEM)
- Close cooperation with leading research institutes and R+D departments



SCHLENK Rolling mill Roth-Bernlohe



SCHLENK Georgensgmünd

Schlenk Metallfolien GmbH & Co.KG
Barnsdorfer Hauptstraße 5
91154 Roth · Germany
Tel.: +49 (0)9171 808-281
E-Mail: battery@schlenk.com

www.schlenk.com

SCHLENK North America Sales Office
40 Nickerson Road
Ashland, MA 01721 · USA

Mr. Thorben Beckmann
Tel: (+1) 508 881 9147 Ext. 341
Cell: (+1) 857 452 7510
E-Mail: thorben.beckmann@schlenk.de



SCHLENK Battery Website



SCHLENK Flyer High Tensile Alloy Foils



SCHLENK Flyer Rolled Foils in Batteries

Data in this publication is based on careful investigations and is intended for information only. All information shall not be binding, shall carry no warranty as to certain ingredients, as to the fitting for a special purpose, as to the merchantability, or as to the industrial property rights of third parties. Any and all users are obliged to carry out tests on their own authority as well as to check the suitability and the danger of the respective product for a particular application. SCHLENK assumes no liability in this regard; neither to the exactness nor to the completeness of the data. We apply our General Sales Conditions to be found on www.schlenk.com. CS 07/22