

High Performance Metal Solutions

# High Performance Materials for Flat Panel Display (FPD)

H.C.Starck 

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# An Industry Leader in Refractory Metals

H.C. Starck Solutions delivers superior quality with material consistency and product reliability. World class quality is achieved through continuous research of new products, development of engineering solutions, and applying them in H.C. Starck Solutions' manufacturing environment to deliver premium products for the most challenging applications.

Nearly 100 years of refractory metals experience is the cornerstone for H.C. Starck Solutions' success in advancing technology metals for rapidly growing industries: aerospace, chemical processing, electronics, industrial, medical, and energy. H.C. Starck Solutions is at the forefront of creating solutions with next-generation materials and fabricated components for a diverse spectrum of markets.

- > **Product Quality and Service**
- > **Research and Development**
- > **Manufacturing Excellence**
- > **Reclamation and Recycling**
- > **Molybdenum Sputtering Targets**



## Strategic Advantages of Working with H.C. Starck Solutions

Our knowledge and experience in the flat panel display market and the latest cutting-edge technologies enables H.C. Starck Solutions to collaborate with customers to create value-added solutions for complex issues facing the industry. Our robust and sustainable vertically integrated supply chain enables us to deliver high performance materials and products seamlessly to the marketplace.

H.C. Starck Solutions is positioned for rapidly evaluating wide ranging compositions of thin films with our sputtering capabilities. Optimized compositions are quickly scaled up for laboratory or sub-scale targets for evaluation at a customer's laboratory. Consequently, full scale production targets are realized with similarly optimized processes based on H.C. Starck Solutions' many years of production experience.

H.C. Starck Solutions offers exceptional customer care with Sales and Technical support.

# Highest Quality Sputtering Target Materials

H.C. Starck Solutions is one of the world's largest producers of molybdenum, tungsten, tantalum and niobium metals, and fabricated products with a robust vertically integrated supply chain for delivering sputter targets for thin film coatings applications. Our global manufacturing facilities produce a broad range of sputtering target materials in all configurations.

## > Highest Quality Sputtering Materials

99.95% Purity

Fully dense

Chemical and metallurgical uniformity

## > Planar Sputtering Targets

High purity

Dimensional precision and tight tolerance

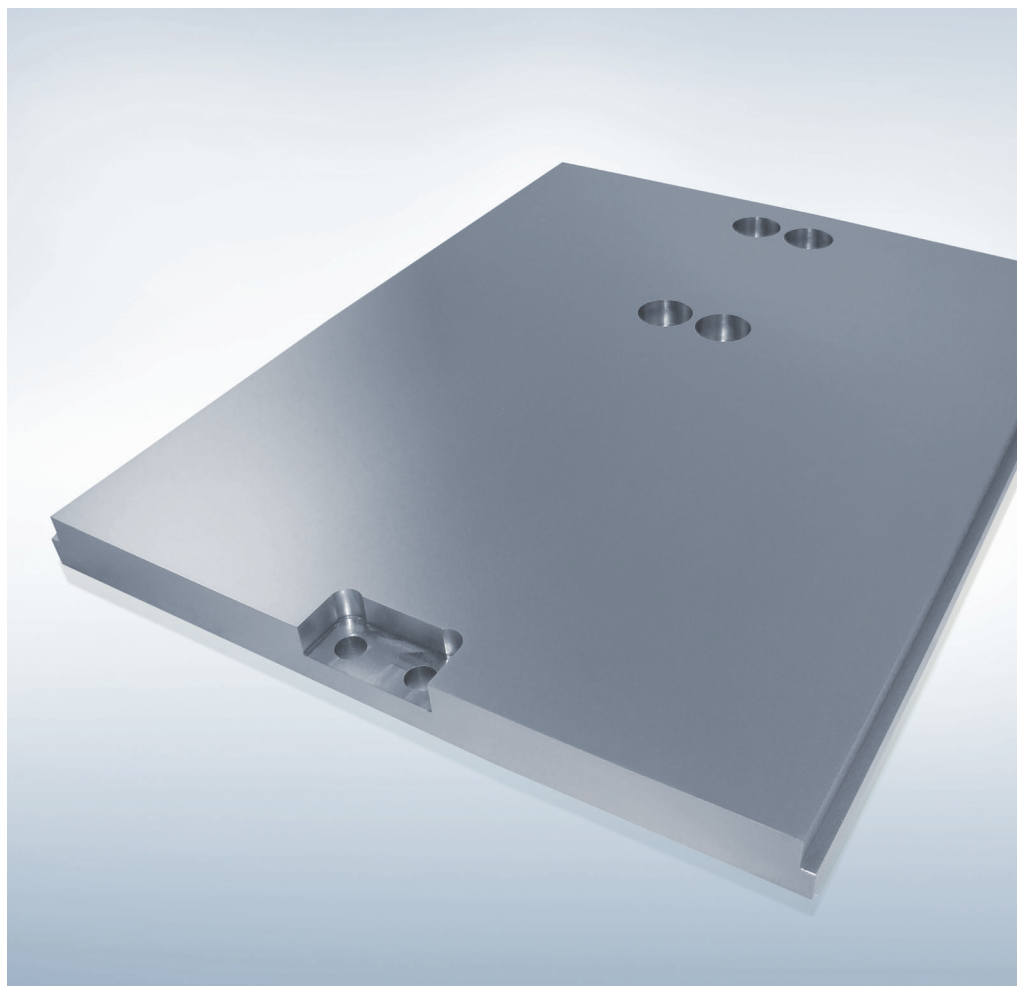
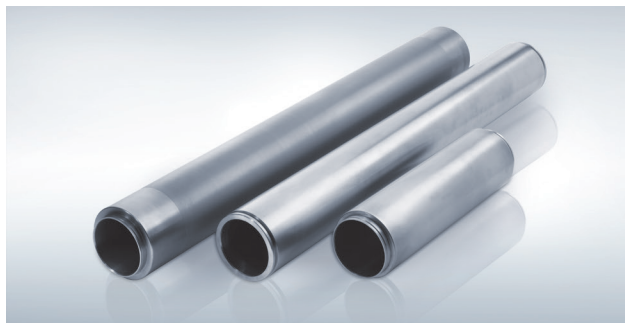
## > Rotary Sputtering Targets

Extruded monolithic rotary target configurations

- Highest powder densities and deposition rates
- Extended target life and material utilization

Unitary sleeves for bonded rotary targets

Integrated manufacturing "under one roof"

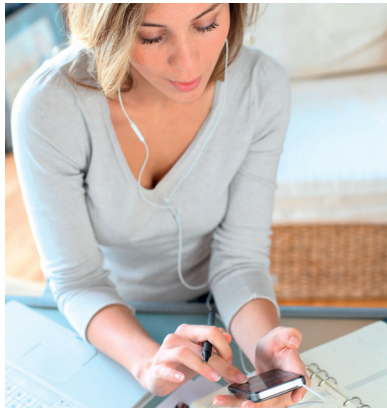




## Diverse Product Portfolio

Molybdenum metal thin films are employed as barrier layers, electrodes, and wiring in a majority of flat panel display applications including televisions and monitors, tablets and mobile devices, smart phones, digital recording devices, GPS, and other display systems. H.C. Starck Solutions offers a diverse product portfolio planar and rotary sputtering targets for all generations of FPD sputtering tools.

H.C. Starck Solutions' planar sputtering targets range in generation sizes including the Gen 5.5 molybdenum target with area dimensions of 1580 mm x 1950 mm. Rotary sputtering targets are produced in monolithic and bonded configurations in lengths of 4 meters or longer per customer specification at our premier extrusion facility. Our extrusion expertise comprises specialty metals and alloy based systems including titanium, molybdenum, tantalum, niobium and other metals for large extrusion applications.



# Innovative Research and Development

Committed to the research and development of thin film products, H.C. Starck Solutions has a renowned research staff dedicated to advancing metals technology for refractory metal sputtering targets. To benefit customers, we continually invest and upgrade our advanced manufacturing and analytical capabilities. H.C. Starck Solutions' evaluates planar and rotary sputtering targets in its Thin Film Materials Laboratory using thin film characterization instrumentation – complete with optical and electron microscopy. In our Material Processing laboratory, we produce evaluation targets with the assistance of a complete chemical analysis lab. Advanced material modeling and simulation capabilities support the rapid development of new products and processes at H.C. Starck Solutions.

## > Comprehensive applications laboratories

### Thin Film Laboratory

- Planar and rotary target deposition chamber
- Co-Sputtering capability, rapid composition optimization
- Thin film characterization physical and electrical

### Metallurgical Laboratory

- Optical microscopy
- SEM with EDS<sup>1</sup> and EBSD<sup>2</sup>
- Mechanical testing / hardness

### Extensive analytical capabilities

- IGA<sup>3</sup>
- ICP<sup>4</sup>
- GDMS<sup>5</sup>

## > Broad engineering and R&D staff

- Recognized leader in refractory metal technology
- Innovated texture control to enhance film uniformity and performance consistency
- Hundreds of patents and technical publications

## > Materials Processing Laboratory

- Rolling (Deformation)
- Cold (CIP) and Hot Isostatic Press (HIP)
- Thermal Treatments

<sup>1</sup> Energy Dispersive X-Ray Spectroscopy

<sup>2</sup> Electron Backscatter Diffraction

<sup>3</sup> Interstitial Gas Analysis

<sup>4</sup> Inductively Coupled Plasma (Mass Spectroscopy)

<sup>5</sup> Glow Discharge Mass Spectroscopy



# H.C. Starck Solutions' Secure Material Supply Chain

H.C. Starck Solutions is one of the leading global producers of technology metals and advanced ceramics. We are committed to ensuring the safety, health and protection of people who come in contact with our products and the environment. As responsible corporate citizens, we meet and are continually striving to exceed governmental, industry and environmental standards worldwide.

H.C. Starck Solutions has implemented a certified Responsible Supply Chain Management System (RSCM) as a core control system to guarantee that only "conflict-free" raw materials will be purchased. The RSCM system ensures efficient and competitive purchasing as well as supports sourcing from suppliers that act in accordance with environmental and social sustainability. With a variety of control mechanisms, H.C. Starck Solutions performs thorough due diligence on all raw material offers based on current OECD and EICC guidelines before any contracts are signed or any materials are accepted.

H.C. Starck Solutions fully supports the position of the Electronics Industry Citizenship Coalition (EICC) and the Organization for Economic Co-operation and Development (OECD) to avoid the use of ores and metals which finance or benefit armed groups in the Democratic Republic of the Congo (DRC) or adjoining countries. We are actively committed to supporting our customers with their diligence and disclosure requirements, including those required by the United States Securities and Exchange Commission's "conflict-mineral" regulations.

H.C. Starck Solutions is one of the first companies to pass a second consecutive audit under the Conflict-Free Smelter (CFS) Validation Program introduced in 2010. The program was created and is driven by the electronics industry for eliminating unethical sources of raw material from their supply chains (including tantalum, tin, tungsten and gold) that have originated in conflict regions where production and trade can be associated with abuse of human rights.

In addition to securing a conflict-free raw material supply chain, H.C. Starck Solutions reclaims spent materials for our customers. A recognized leader in "Green Technology", H.C. Starck Solutions is a founding member of the Center for Resource Recovery and Recycling (CR3) coalition. H.C. Starck Solutions also was awarded the Sony "Green Partner" certification, one of the best established programs of its kind, and is effectively a "gold standard" of the electronics industry. H.C. Starck Solutions' environmental stewardship, robust supply chain, energy efficiency and recycling are foundational pieces of our strategy and corporate culture.





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