Sputtering Targets, Pellets & Wire (Vapor Deposition) (For Flat Panel Display, Photovoltaic, Semiconductor, and Other Applications)

ULVAC, Inc. delivers total solutions for manufacturing equipment needed to produce solar cells, FPD, integrated circuit devices and countless other products. As part of these solutions, the ULVAC global production system delivers high quality, stable and low cost supply of sputtering targets and various vapor deposition materials by making maximum use of its best features as an equipment manufacturer. ULVAC facilities also include the Institute for Super Materials which is a professional R&D facility for new materials. ULVAC also works closely with nearby production plants to support a broad range of needs ranging from trial production of samples for next-generation materials, to material supply, and technical consultations on mass production line operation.

Enhanced global system support ranging from R&D of new materials to production and supply

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Sputtering Targets for Flat Panel Display Applications

Large Sizes & Diverse Display Types
In the FPD (Flat Panel Display) Market, We Constantly Work to Maintain a Stable, High-Quality Material Supply

WE DO THE FOLLOWING to ensure our customers have stable, high-quality materials needed for flat-panel displays

- We obtain materials from sources all over the world
- Our quality control facilities and system support large targets (supports G8 generation and even super-large glass substrates)
- We work along with the Chiba Institute of Super Materials to ensure that ideal materials are provided to customer production processes

- We support sputtering targets for all fields including TFT, OLED (LTPS: Low-temperature polysilicon) and touch panels.
- Ultrasonic defect testers ensure meticulous quality assurance!

FPD manufacturing equipment sizes are becoming larger and larger so sputtering target dimensions are also increasing. To improve both production equipment and QA equipment, ULVAC has installed large ultrasonic test equipment to make meticulous defect inspections of materials and bonding inspections. Using this equipment has helped ULVAC drastically cut down on arcing during sputtering and deliver high quality targets.

- High-reliability metal bonding technology

Large sputtering targets are very heavy so technology for bonding to a cooling plate (backing plate) is extremely important. ULVAC has installed bonding equipment to support deposition of larger glass substrate, and realized an all-inclusive target supply system.

ULVAC’s High Quality Targets Contribute to High-Functional Films for FPDs.

- ITO Targets

<table>
<thead>
<tr>
<th>Four Major Features of ULVAC Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Stable and enhanced discharge during deposition through refinement and high dispersion of SnO₂</td>
</tr>
<tr>
<td>- Good roughness of target surface</td>
</tr>
<tr>
<td>- High stability of film resistance after deposition</td>
</tr>
<tr>
<td>- Low particle</td>
</tr>
</tbody>
</table>

- Other Targets

<table>
<thead>
<tr>
<th>Product Line of ITO Targets</th>
</tr>
</thead>
<tbody>
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<td></td>
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</tbody>
</table>

- Targets for manufacturing equipment of FPDs

<table>
<thead>
<tr>
<th>Application Field</th>
<th>Materials</th>
<th>Manufacturing Method</th>
<th>Purpose of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low temperature poly-Si TFT materials</td>
<td>Al (Sn) &amp; Al alloy</td>
<td>Melting method</td>
<td>Wiring materials</td>
</tr>
<tr>
<td>Mobile terminals/ monitors</td>
<td>Ti (4N)</td>
<td>Melting method</td>
<td>Electrode/barrier materials</td>
</tr>
<tr>
<td>Rear-projection televisions</td>
<td>SnO₂ (3N) Powder sintering</td>
<td>Electrode/barrier materials</td>
<td></td>
</tr>
<tr>
<td>FPD</td>
<td>Al (Sn) &amp; Al alloy</td>
<td>Melting method</td>
<td>Wiring materials</td>
</tr>
<tr>
<td>PDP</td>
<td>Ti (4N) Al (Sn) Powder sintering</td>
<td>Transparent conduction films</td>
<td></td>
</tr>
<tr>
<td>OLEO (organic EL)</td>
<td>Ag (3N) Powder sintering</td>
<td>Transparent conduction films</td>
<td></td>
</tr>
<tr>
<td>Mobile terminals</td>
<td>Ag &amp; Ag alloy</td>
<td>Melting method</td>
<td>Barium electrode</td>
</tr>
<tr>
<td>FED/SAM</td>
<td>Al &amp; Al alloy</td>
<td>Melting method</td>
<td>Wiring/ electrode</td>
</tr>
<tr>
<td>Monitors/TVs</td>
<td>Cr (5N)</td>
<td>Powder sintering</td>
<td>Barrier/ adhesion film material</td>
</tr>
<tr>
<td></td>
<td>TiO₂ (4N)</td>
<td>Melting method</td>
<td>Wiring materials</td>
</tr>
<tr>
<td></td>
<td>Nb (3N)</td>
<td>Melting method</td>
<td>Electrode materials</td>
</tr>
<tr>
<td></td>
<td>Si &amp; SiO₂ (4N)</td>
<td>Powder sintering</td>
<td>Insulating/ under-layer material</td>
</tr>
<tr>
<td>Mobile phones/ terminals</td>
<td>Ag alloy (4N)</td>
<td>Melting method</td>
<td>Sn selective electrode materials</td>
</tr>
<tr>
<td></td>
<td>Al (Sn) &amp; Al alloy</td>
<td>Powder sintering</td>
<td>Transparent conduction films</td>
</tr>
<tr>
<td></td>
<td>Cu (Sn) &amp; Cu alloy</td>
<td>Melting method</td>
<td>Wiring materials</td>
</tr>
<tr>
<td></td>
<td>Mgo (3N) Powder sintering</td>
<td>Electrode/barrier materials</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cr (3N) Powder sintering</td>
<td>Electrode/barrier materials</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ti (2N) Powder sintering</td>
<td>Electrode/barrier materials</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TiO₂ (4N) Powder sintering</td>
<td>Transparent conduction films</td>
<td></td>
</tr>
</tbody>
</table>

- Cu-Mg-Al Alloy for low-resistance Copper Wiring

<table>
<thead>
<tr>
<th>Cu-Mg-Al Alloy</th>
<th>for Low-Resistance Copper Wiring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good lower adhesion layer in low-resistance Cu wiring process</td>
<td></td>
</tr>
<tr>
<td>Ideal target for deposition forming in low-resistance wiring processes. (Stacking structure uses Cu-Mg-Al alloy as adhesion layer for pure copper film)</td>
<td></td>
</tr>
<tr>
<td>Good adhesion to glass substrates, oxide layers (ITO, etc.), and silicon system under layers (SiO₂).</td>
<td></td>
</tr>
<tr>
<td>Wet etch processing is easy because the copper material is similar to the wiring layer material. (Processing can also use etching solution (single fluid) not containing hydrogen peroxide or fluoric acid.)</td>
<td></td>
</tr>
<tr>
<td>Low-cost process</td>
<td></td>
</tr>
<tr>
<td>Inexpensive target material</td>
<td></td>
</tr>
</tbody>
</table>

- Wiring resistance of various metal materials

| Cu | 2.2μΩcm |
| Mo | 12-15μΩcm |
| a-Ta | 25μΩcm |
| Cr | 20μΩcm |
| Al | 4-5μΩcm |
| Al | 3-3.5μΩcm |
| Ag | 3.0μΩcm |

*Silver (Ag) has low bulk resistance but its resistivity as a thin film is the same as aluminum (Al).
Sputtering Targets for Photovoltaic Applications

Sputtering Targets for Total Material Support of Thin Film Solar Cell Manufacturing Equipment

Besides promoting widespread use of its turn-key or “ready-to-go” thin-film solar cell manufacturing equipment, ULVAC also provides sputtering targets made from materials ideal for passivation, buffer and electrode layers in amorphous silicon solar cells and compound semiconductor (CIGS) solar cells. ULVAC responds to needs for transparent, electrically conductive films widely used not only in solar cells but also in PPD and touch panels. It provides for example, GZO and AZO thin films using zinc that is a plentiful resource compared to ITO by utilizing an all-inclusive integrated system ranging R&D, to production engineering, and global supply.

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**Thin Film Amorphous Silicon Solar Cell and Materials**

- **Transparent Front-Side Electrode**
- **High-Resistance Buffer Layer**
- **Light Absorption Layer**
- **Rear-Side Electrode**
- **Glass Substrate**

**Role of protective layer in preventing silver from oxidation and sulfuration**

Buffer layer between silver and silicon prevents alloying of silver and silicon in reflecting sunlight from oxidation and sulfuration.

**Role of negative electrode in reflecting sunlight**

Buffer layer between silver and silicon prevents alloying of silver and silicon.

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**Recycling of Sputtering Targets**

**ULVAC Environmental Work**

- **Resource Recovery**
- **Recycle**
- **Reuse**

At ULVAC, resource recovery, recycling and reuse of valuable rare metals are implemented in a proactive manner to pursue efficient use of sputtering targets.

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**Thin Film Compound (CIGS) Solar Cell and Materials**

- **Transparent Front-Side Electrode**
- **High-Resistance Buffer Layer**
- **Light Absorption Layer**
- **Rear-Side Electrode**
- **Glass Substrate**

**Multi-Dimensional Vapor Method, Seeding Method**

**Sputtering Method or MOCVD**

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**Sputtering Targets for Photovoltaic Applications**

**Target Production (Metallic Processing/Smelting/Quenching/Check)**

**Surface Treatment/Heat Treatment**

**Take Off Coating/Recognition**

**Recycling of Target Materials**

**Purity/Refine Process of Target Materials**

**Target Recovery/Recycling**

**Delivery of Materials**

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Source: Prof. Toke Nakada (College of Science and Engineering, Aoyama Gakuin University) Public relations magazine “ULVAC” (9th revised edition)
Sputtering Targets for Semiconductor Applications

ULVAC Semiconductor Target Materials — Always a Leader in Materials on the Cutting Edge of New Technology

Sputtering targets must meet ever tougher standards for high quality to produce sub-micron scale and wafer targets in ever larger sizes:

- Low particle
- Good film uniformity
- High usage efficiency

— To develop and produce high quality sputtering targets, ULVAC carefully evaluates which manufacturing method to use for each material to meet the following product quality goals.

Sputtering targets made using optimum manufacturing methods!

ULVAC has developed 2 types of tungsten targets for different manufacturing methods depending on the particular application required by the sputterer. One type was developed for products at a purity grade of 5N and is an inexpensive and employs the powder sintering method. High-purity CVD tungsten target boasting a purity grade of 7N and using CVD (chemical vapor deposition) on sections requiring higher quality.

ULVAC in this way provides the user with high performance by using the ideal target manufacturing method to meets specifications needed for a particular semiconductor process.

Low-particle targets

ULVAC has developed sputtering targets that suppress generation of particles that can be the source of problems in the sputtering process. Gaseous elements are one factor in causing particle emissions especially in aluminum targets and we are working to lower emissions by utilizing a vacuum melting method in the refining and ingot purification processes.

Comparison of Metal Microstructures in Tungsten Targets

ULVAC Sputtering Targets for Semiconductor Applications

ULVAC uses manufacturing processes that ensure high uniformity and a fine metal microstructure in most of its targets for semiconductor products including high purity cobalt targets and titanium targets.

- Attaining high uniformity by adjusting the metal microstructure
- Meticulous quality control system

Integrated process manufacturing at ULVAC takes product characteristics and contours into account during production. Sophisticated analysis/evaluation systems such as the GDMS (glow discharge mass spectrometer) ensure purity along with a high level of quality.

Target Material for Mainstream 300mm Wafers

<table>
<thead>
<tr>
<th>Target Material</th>
<th>Al-0.5Mass%Cu</th>
<th>Ti</th>
<th>Cu</th>
<th>Ta</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purity</td>
<td>6N5up (low-U, Th specifications)</td>
<td>4N5up</td>
<td>6Nup</td>
<td>5N, 6N, 7N</td>
<td></td>
</tr>
<tr>
<td>Manufacturing Method</td>
<td>Induction Melting Method (Vacuum)</td>
<td>Arc Melting Method/EII Melting Method</td>
<td>Making Method (Atmosphere)</td>
<td>EII Melting</td>
<td>Sinter, CVD</td>
</tr>
<tr>
<td>Backing plate Material</td>
<td>Aluminum or Copper Alloy</td>
<td>Aluminum Alloy</td>
<td>Aluminum Alloy</td>
<td>Copper Alloy</td>
<td></td>
</tr>
<tr>
<td>Bonding Method</td>
<td>Electron Beam Welding, Integrated Part Structure, or Metal Bonding</td>
<td>Diffusion Bonding</td>
<td>Diffusion Bonding</td>
<td>Diffusion Bonding</td>
<td></td>
</tr>
</tbody>
</table>

Evaporation Deposition Materials

<table>
<thead>
<tr>
<th>Materials</th>
<th>Purity</th>
<th>Type</th>
<th>Size</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cu</td>
<td>5N</td>
<td>Powder</td>
<td>2000</td>
<td>2000</td>
</tr>
<tr>
<td>Ni</td>
<td>5N</td>
<td>Powder</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>Al</td>
<td>5N</td>
<td>Powder</td>
<td>5000</td>
<td>5000</td>
</tr>
<tr>
<td>Cr</td>
<td>5N</td>
<td>Powder</td>
<td>1000</td>
<td>1000</td>
</tr>
</tbody>
</table>

Our high-purity vacuum deposition materials are being used in all fields involving thin film electronic devices. Vapor deposition materials manufactured in a clean environment and under a sophisticated quality assurance system provide our customers with complete satisfaction.

Besides our standard products, please feel free to consult us for special needs involving custom materials or contours, etc.

We also handle all types of vacuum evaporation source components. Please tell us what you need and we will make every effort to fill your order.