High purity AMPERTEC™ Refractory Metal Chlorides are produced for semiconductor/electronic, optical and chemical industries.

AMPERTEC™ Refractory Metal Chlorides are manufactured with different crystal sizes. A large crystal size reduces moisture sensitivity and improves handling and dosage. In contrast, a smaller crystal size increases the reactivity.

AMPERTEC™ Refractory Metal Chlorides exhibit high vapour pressures of 1 bar in the range of 233 – 337 °C. This is benefiting chemical vapor deposition (CVD) and atomic layer deposition (ALD) processes.

Up to 99.995 % pure AMPERTEC™ Tantalum Pentachloride is produced with ultra low thorium and uranium contents for semiconductor applications.

Applications

> Ultracapacitors
> Batteries
> Fuel cells
> Electrodes
> Catalysts
> Synthesis of CVD precursors

> Optical coatings
> High-k dielectric layers
> Diffusion barrier layers
> High corrosion and thermal resistant layers
> Synthesis of oxide, carbide and nitride powders

Application Methods

> CVD/ALD deposition of metal, oxide, nitride and carbide layers
> Flame pyrolysis
> Sol-gel
> Chemical synthesis
Quality

> H.C. Starck maintains high quality standards within its production line of **AMPERTEC**™ Refractory Metal Chlorides. This results in high purity grades of up to 99.995 %!
> Store in a dry place
> WCl₆: store in a dry and dark place
> NbCl₅, WCl₆: every 3 months the bottles must be intensively shaken

Purity of **AMPERTEC**™ Tantalum Pentachloride

<table>
<thead>
<tr>
<th>Element</th>
<th>Al</th>
<th>Ca</th>
<th>Cr</th>
<th>Fe</th>
<th>K</th>
<th>Mg</th>
<th>Nb</th>
<th>Ni</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>high purity 99.93 %</td>
<td>2</td>
<td>3</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>20</td>
<td>0.5</td>
<td>1</td>
</tr>
<tr>
<td>highest purity 99.995 %</td>
<td>2</td>
<td>1</td>
<td>0.3</td>
<td>1</td>
<td>0.5</td>
<td>1</td>
<td>5</td>
<td>0.5</td>
<td>1</td>
</tr>
</tbody>
</table>

All values are in max. ppm, crystal size < 1 < 3
Alternate crystal sizes on request

Purity of **AMPERTEC**™ Niobium Pentachloride

<table>
<thead>
<tr>
<th>Element</th>
<th>Al</th>
<th>Ca</th>
<th>Cr</th>
<th>Fe</th>
<th>K</th>
<th>Mg</th>
<th>Ni</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>high purity 99.93 %</td>
<td>4</td>
<td>3</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>25</td>
</tr>
<tr>
<td>highest purity 99.995 %</td>
<td>4</td>
<td>3</td>
<td>0.3</td>
<td>1</td>
<td>0.5</td>
<td>1</td>
<td>0.5</td>
<td>12</td>
</tr>
</tbody>
</table>

All values are in max. ppm, crystal size < 3
Alternate crystal sizes on request

Purity of **AMPERTEC**™ Tungsten Hexachloride

<table>
<thead>
<tr>
<th>Element</th>
<th>Al</th>
<th>Ca</th>
<th>Cr</th>
<th>Fe</th>
<th>Mg</th>
<th>Ni</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>WCl₆ &gt; 99.9 %</td>
<td>10</td>
<td>5</td>
<td>20</td>
<td>30</td>
<td>5</td>
<td>30</td>
<td>5</td>
</tr>
</tbody>
</table>

All values are in max. ppm, crystal size < 2 mm

**Physical properties of **AMPERTEC**™ Refractory Metal Chlorides**

<table>
<thead>
<tr>
<th>Chloride</th>
<th>Melting Point / °C</th>
<th>Boiling Point / °C</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>TaCl₅</td>
<td>216</td>
<td>233</td>
<td>white</td>
</tr>
<tr>
<td>NbCl₅</td>
<td>205</td>
<td>248</td>
<td>yellow</td>
</tr>
<tr>
<td>WCl₆</td>
<td>275</td>
<td>337</td>
<td>black-violet</td>
</tr>
</tbody>
</table>

1 bar = 1000 mbar = 1000 hPa

Hazard identification in Advertising


1) harmful; 2) corrosive; 3) irritant; 4) Acute toxicity Category 4;
5) Skin corrosion Category 1B; 6) Specific target organ toxicity - single exposure Category 3
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The values in this publication are typical values and do not constitute a specification.