

# Technical Specification of CVD Coatings – Refractory Metals & Carbides

## Tungsten (W), Tungsten Carbide (W<sub>3</sub>C), Tungsten Carbide (W<sub>2</sub>C), Rhenium (Re), Iridium (Ir) and Molybdenum (Mo)

### Applications

W – used for glass-to-metal seals, filaments, and x-ray targets. A crack free material is produced which is impervious to helium.

W<sub>3</sub>C – used for cutting surfaces, armour-piercing ammunition, neutron reflectors and extrusion dies.

W<sub>2</sub>C – used for hard-metal applications such as electronics, metal and plastic machining, wood cutting and other tools.

Re – used in catalysts, thermocouples and electrical contacts.

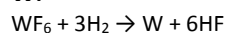
Ir – used for rocket nozzles.

### Properties

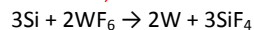
Coating	W	W <sub>3</sub> C	W <sub>2</sub> C	Re	Ir	Mo
Purity (%)	>99.9	99.5	99.5	>99.9	99.9	99.9
Density (g/cm <sup>3</sup> )	19.3	14.8	15.6	21.0	22.7	10.3
Flexural Strength (MPa)	980	315	315	410	1000	700
Hardness (Kg/mm <sup>2</sup> )	3430	2000-2500	1800	2450	1760	1530
Thermal Expansion Coefficient (10 <sup>-6</sup> /°C)	4.5	4.0-4.7	4.5	6.6	6.8	4.8
Thermal Conductivity (W/mK)	173	30	225	48	147	138
Electrical Resistivity (Ωcm)	5.5x10 <sup>-6</sup>	1.7x10 <sup>-9</sup> - 2.2x10 <sup>-9</sup>	>1x10 <sup>14</sup>	19.3x10 <sup>-6</sup>	4.71x10 <sup>-9</sup>	15.4x10 <sup>6</sup>
Standard Thickness	5µm-2mm	5-100µm	5-100µm	1µm-2mm	1-2µm	5-20µm
Oxidation Temperature (°C)	600-850	500-800	450	497	2280	1100
Friction Coefficient	0.41-0.51	0.20-0.25	0.20-0.25	0.40	0.58	0.44-0.46
Colour	Grey-white	Grey	Grey-black	Grey-white	Silver-white	Grey-black

### CVD Methods

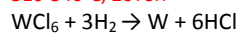
#### W:



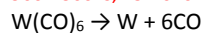
300-700°C, 10Torr-1atm



310-540°C, 20Torr

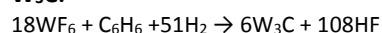


900-1300°C, 15-20Torr



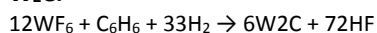
250-600°C, 20Torr

#### W<sub>3</sub>C:



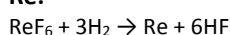
670-720°C, <10Torr

#### W<sub>2</sub>C:

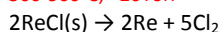


670-720°C, <10Torr

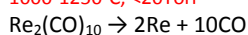
#### Re:



500-900°C, <20Torr

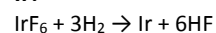


1000-1250°C, <20Torr



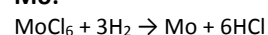
400-600°C, 200Torr

#### Ir:

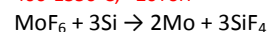


400-450°C, up to 1atm

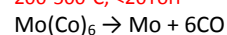
#### Mo:



400-1350°C, <20Torr



200-500°C, <20Torr



300-700°C, 1Torr to 1 atm



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