

Cobalt Powder

Technical Information Bulletin

Powders That Shape Your World

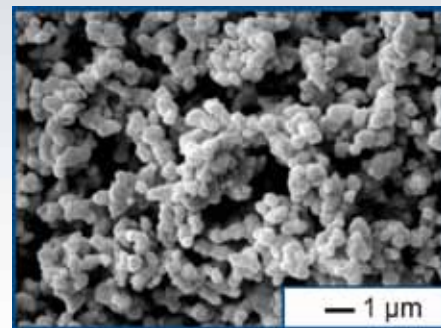


Cobalt powder is specifically designed and manufactured for use in high-quality cemented carbide and related products. The hard metal industry demands cobalt powder with high standards of purity, fine particle size and consistent particle size distribution. When milled with carbide powders, fine particle size assures good spatial distribution of the cobalt aiding in the uniformity of liquid-phase sintering and the elimination of fine porosity.

GTP offers six types of cobalt powder Ultra-Fine (Ultra-Fine, waxed Ultra-Fine PEG, waxed Ultra-Fine Paraffin) and Extra-Fine (Extra-Fine, waxed Extra-Fine PEG, waxed Extra-Fine Paraffin)



Typical Physical Properties			
Element	units	Ultra-Fine	Extra-Fine
Fisher Size	μm	0.90	1.20
D10 Laser Diffraction, Dry	μm	1.7	2.0
D50 Laser Diffraction, Dry	μm	3.3	4.0
D90 Laser Diffraction, Dry	μm	5.8	8.0
Apparent Density	g/cc	1.2	1.3
Tap Density	g/cc	2.5	2.7
Surface Area	m^2/g	1.9	1.3

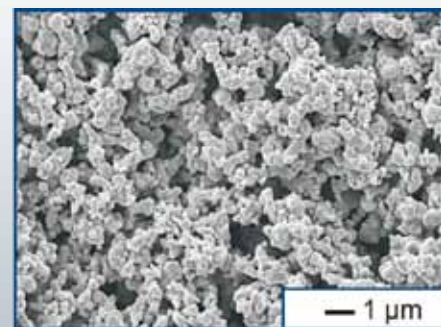


Ultra Fine Cobalt

Features & Advantages:

- Hydrometallurgical process
- Spherical shape
- Reduced milling time
- Finer microstructure
- Isotropic shrinkage
- No cobalt pooling
- Homogenous microstructure

Typical Physical Properties			
Element	units	Ultra-Fine	Extra-Fine
Oxygen	%	0.550	0.400
Carbon	%	0.150	0.110
Sulfur	%	0.004	0.005
Iron	%	<0.002	<0.001
Nickel	%	0.050	0.050
Aluminum	%	<0.001	<0.001
Cadmium	%	<0.001	<0.001
Calcium	%	<0.001	NA
Chlorine	%	<0.001	<0.001
Copper	%	<0.001	<0.001
Gold	%	NA	<0.001
Lead	%	<0.001	<0.001
Magnesium	%	<0.001	<0.001
Manganese	%	<0.001	<0.001
Molybdenum	%	<0.001	NA
Potassium	%	<0.001	<0.001
Silicon		NA	<0.001
Sodium	%	NA	<0.001
Zinc	%	<0.001	<0.001



Extra Fine Cobalt

Features & Advantages:

- Hydrometallurgical process
- Spherical shape
- Homogenous microstructure

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Cobalt Particle Effects

The Role of Particle Size and Shape:

The cobalt binder in cemented carbides must be evenly distributed on carbide particle surfaces during milling. Thus cobalt particles must be small initially or deagglomerate or flatten and break up during milling. Particle shape is related to ease of flow. Binder distribution efficiency becomes more important when carbide particles are small and cobalt content is low. Particle shape, state of agglomeration, and milling response are different for cobalt powders made by hydrometallurgy, oxalate and thermal reduction processes respectively.

Comparison of Cobalt Powders:

Figures 1 and 2 compare the characteristic spherical agglomerated nature of hydrometallurgy powder with the rod like particles of oxalate powder. It is seen that hydrometallurgy powder has smaller crystallites than oxalate. Figures 3 and 4 compare hydrometallurgy and oxide reduction powders in a larger size range. Despite the large agglomerate size, the constituent crystallite size of the hydrometallurgy powder is relatively small.

Particle size is commonly measured by air flow through a packed column of powder to give a Fisher number (FSSS), and by laser diffraction to give median particle diameter (d_{50}). A combined measure of size and shape is obtained by measurement of specific surface area (SA) using a gas absorption technique (BET). Another measure of size (d_{SA}) can be calculated from SA using equations that relate to SA, particle density and particle volume, and take account of differences in shape. Typical numerical data for a range of cobalt powders are shown in chart 1.

Comparison of Cobalt Powders:

Distribution in milling is aided by small particle size. During milling it is expected that hydrometallurgy agglomerates will break down to small spherical crystallites of a size represented by d_{SA} . This should promote uniform contact between cobalt and carbide surfaces, especially in milling mixtures with submicron carbide particles and/or low cobalt content. The state of agglomeration in the cobalt powder is represented by the ratio d_{50}/d_{SA} , with larger values indicating more agglomeration. The breakdown of hydrometallurgy agglomerates is shown in Chart 2.

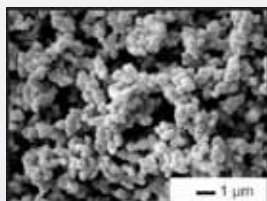


Figure 1 - Hydrometallurgy Cobalt - Ultrafine

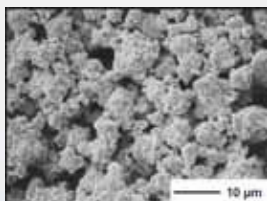


Figure 3 - Hydrometallurgy Cobalt - 5M

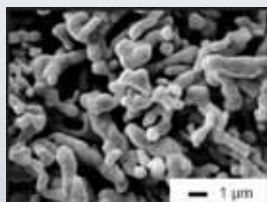


Figure 2 - Oxalate Cobalt - Extrafine

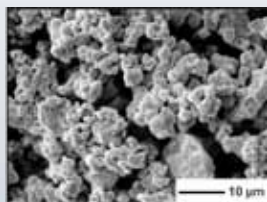


Figure 4 - Oxide Reduction Cobalt - 400 mesh

Chart 1:

	FSSS	d_{50} μm	SA m ² /g	d_{SA} μm	d_{50}/d_{SA}
Hydrometallurgical					
Half Micron	0.6	2.3	3.4	0.20	12
Ultrafine	0.9	3.0	2.2	0.31	10
2M	1.7	5.7	1.4	0.48	12
5M	4.0	13	0.8	0.84	15
Oxalate					
SMS	0.8	3.0	2.0	0.46	7
Extrafine	1.4	3.7	1.0	0.92	4
Oxide Reduction					
CoUF	1.0	3.5	1.5	0.44	8
CoC	1.5	4.8	1.2	0.56	9
	4.5	14	0.5	1.4	10

Chart 2:

Cobalt Powder	d_{50} (μm)		
	0 min	30 min	16 h
Hydrometallurgy 5M	15.5	11.2	6.6
Oxide Reduction 400 MP	17.2	14.7	10.5

- ASTM B859: Rod Milling
- This milling data is consistent with the d_{50}/d_{SA} values shown for the two powders

Certification

Lot data for the above physical and chemical specifications is reported in a laboratory test that is provided for each shipment. Information is available for customer evaluation.

Packaging

Typical packaging is one hundred kilograms (100kg) per 18 gallon (68.1 liter) drum with polyethylene or aluminized liner.