Technical Information Ceramics
(Standard Tolerances)

Fine Ceramics technical guide				
Dimensions a) b)			**min**	**max**
●	diameter	mm	0.4	820
◎	diameter (inner)	mm	0.15	450
■	edge length	mm	1	1500
Dimensional tolerances				
	as sintered	± 1% (min ± 0.3 mm)		
	grinded	according to ISO 2768 m (1989)/JIS B 0405 m		
Shape and positional tolerances				
—	straightness	according to ISO 1101 (2012)		
▬	flatness	according to ISO 1101 (2012)		
⊥	perpendicularity	according to ISO 1101 (2012)		
=	parallelism	according to ISO 1101 (2012)		
Surface roughness				
▼▼▼▼	precision maching	according to ISO 4287(1997)/JIS B 0601		
▼▼	general machining	according to ISO 4287(1997)/JIS B 0601		
Surface modification				
	mechanical machining	grinding, lapping, polishing, blasting		
	laser machining	marking		
	bonding	resin, glass, Cu metalization		
	coating (thin film)	Al_2O_3, SiC, TiN, TiC, DLC, Ag, Ni, Au		

a) forming technology dependent
b) material dependent

ISO 2768 m (1989)	
Dimensions [mm]	**Tolerance [mm]**
0,5–3	± 0.1
> 3–6	± 0.1
> 6–30	± 0.2
> 30–120	± 0.3
> 120–400	± 0.5
> 400–1000	± 0.8

ISO 1101 (2012) – ▱ //	
Dimensions [mm]	**Tolerance [mm]**
to 10	0.05
> 10–30	0.1
> 30–100	0.2
> 100–300	0.4
> 300–1000	0.6

smaller tolerances on request

ISO 1101 (2012)	
Dimensions [mm]	**Tolerance [mm]**
to 100	0.4
> 100–300	0.6
> 300–1000	0.8

ISO 4287(1997)		
Ra [µm]		**Rmax [µm]**
▽	0.2	0.8
▽	1.6	6.3
▽	6.3	25
▽	25	100

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Ferrofluidic® Vacuum Seal

Welded Metal Bellows
Product of KSM Corporation

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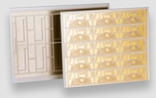
Contract Manufacturing Services

Polycold® Cryogenerators
Product of Brooks Automation, Inc.

Temescal Precision Vacuum Coating Systems

Ceramics

Metal Matrix Composites
Product of Japan Fine Ceramics Co., Ltd.



Direct Bonded Copper

Thermal Solutions

Ferrofluid

Fabricated Quartzware

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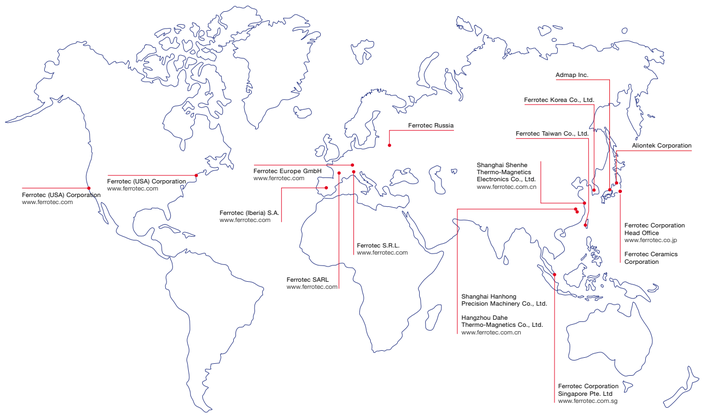
Photoveel is a registered name for the machinable ceramics products from Ferrotec Ceramics Corporation.

Ferrotec
Ceramics

Fine Ceramics for High-Tech Applications

- High purity
- High rigidity
- High hardness
- High strength
- Wear resistance
- Heat resistance
- Chemical resistance
- Plasma resistance
- Thermal conductivity

Ferrotec Global Network



FerroTec ceramics was founded as a manufacturer of machinable ceramics in 1984 and is headquartered in Tokyo, Japan. In 1998, we acquired the fine ceramics business of Sumitomo Metal Industries, and now lead the ceramics industry for structured ceramics in semiconductor processes and inspection equipment. In addition, from 2008, we have advanced our global business under the Ferrotec group using our international sales network (USA, Europe and Asia) and overseas production capability in China.

As a leading manufacturer of a broad range of high purity advanced ceramic materials, FerroTec fabricates precision parts and components for a variety of applications and industries including semiconductor processing equipment, integrated circuit testing and medical diagnostic systems.

FerroTec offers a considerable product line of high-tech ceramics and extensive fabrication, processing and high precision machining capabilities as our core competencies. We have divided our ceramic manufacturing into three materials categories. Advanced FINE CERAMICS with high structural properties, MACHINABLE CERAMICS (Photoveel series) enabling outstanding precision features and MMC (Metal Matrix Composites) materials, which offer unique properties due to the combination of metallic and ceramic materials.

We manufacture our own ceramic materials, so we have a thorough understanding of ceramics and our material expertise will help guide you to your optimal material. Whether you are developing a new component, exploring new materials for an existing component or you are looking for manufacturing alternatives on an existing ceramic design, we specialize in fabricating custom ceramic parts for your designs and applications.

Material Properties and Characteristics

FerroTec Ceramics

Fine Ceramics

Material				Alumina (Al_2O_3)						Silicon Nitride (Si_3N_4)	Silicon Carbide (SiC)	Aluminum Nitride (AlN)	Zirconia (ZrO_2)	Low themal expansion ceramics
Material code				**AS999**	**AT999**	**ACM998**	**AM997**	**AM997QII**	**ACM96**	**SN606**	**SC902E**	**ALN94**	**YZT 94**	**LE101**
General Properties	**Main component purity**		**wt%**	99,99	99,9	99,8	99,7	99,7	96	90	97	94	–	–
	Color			White	–	Whitish yellow	Whitish yellow	–	White	Gray	Black	Light gray	Whitish yellow	Gray
	Density		**g/cm³**	3,95	3,92	3,93	3,93	3,93	3,74	3,16	3,15	3,31	≥ 6.0	2,55
	Water Absorption		**%**	0	0	0	0	0	0	0	0	0	0	0
Mechanical Properties	**Bending Strength**		**MPa**	390	400	370	390	390	350	750	490	345	>1000	200
	Young's Modulus		**GPa**	380	385	370	375	385	320	285	400	320	205	140
	Vickers Hardness		**GPa**	18	16	16	18	17	14	16	22	11	>12	–
Thermal Properties	**Max. Operating Temperature**		**˚C**	1600	1600	1600	1600	1600	–	1200	1600	1000	–	–
	Coefficient of Thermal Expansion	**RT~500˚C**	**1/˚C(x10⁻⁶)**	7,0	7,9	7,2	7,0	7,0	7,2	2,7	3,8	4,4	9,6	<0.5
	Coefficient of Thermal Conductivity		**W/m·K**	33	34	32	33	33	24	23	170	150	3	–
	Thermal Shock Resistance		**ΔT(˚C)**	200	200	250	200	200	200	700	300	400	300	–
Electrical Properties	**Volume Resistivity**	**25 ˚C**	**Ω·m**	10^{15}	10^{15}	10^{14}	10^{16}	10^{15}	10^{15}	10^{16}	10^{4}	10^{14}	10^{14}	10^{14}
		300 ˚C		10^{12}	10^{14}	10^{14}	10^{13}	10^{14}	10^{9}	–	10^{2}	10^{10}	–	10^{12}
		500 ˚C		10^{9}	10^{11}	10^{10}	10^{10}	10^{12}	10^{7}	–	10	10^{7}	–	10^{10}
		800 ˚C		10^{7}	10^{8}	10^{8}	10^{9}	10^{5}	10^{5}	–	10	10^{5}	–	10^{8}
	Dielectric Constant	**10 GHz**		9,9	9,8	9,9	9,7	9,7	9,4	8	–	8,5	33	4,9
	Dielectric Loss (tanδ)		10^{-4}	0,5	4	10	1	0,15	38	6,1	–	30	520	5
	Q Factor (1/tanδ)		10^{4}	2	0,25	0,1	1	6,7	0,03	0,16	–	0,03	0,002	0,2
	Dielectric Breakdown Voltage		**kV/mm**	18	17	15	18	18	14	14	–	15	11	23
Main Characteristics														
▼ Low ▲ High				**96%–99.99% purity** ▼ Price ▲ Purity ▲ Electrical insulation ▲ Hardness ▲ Heat resistance ▲ Wear resistance ▲ Plasma resistance ▲ Corrosion resistance						▲ Thermal shock resistance ▲ Toughness ▲ Heat resistance ▲ High (temp.) strength	▲ Hardness ▲ Wear resistance ▲ Rigidity ▲ High (temp.) strength ▲ Thermal conductivity ▲ Corrosion resistance ▲ Plasma resistance	▲ Thermal conductivity ▲ Heat radiation ▼ Density ▲ Plasma resistance	▲ Strength ▲ Toughness ● CTE ~10x10-6 1/K	▼ Density ▼ Expansion

The chart is intended to illustrate typical mechanical properties of test specimens. Property values may vary according to manufacturing process and product configurations.