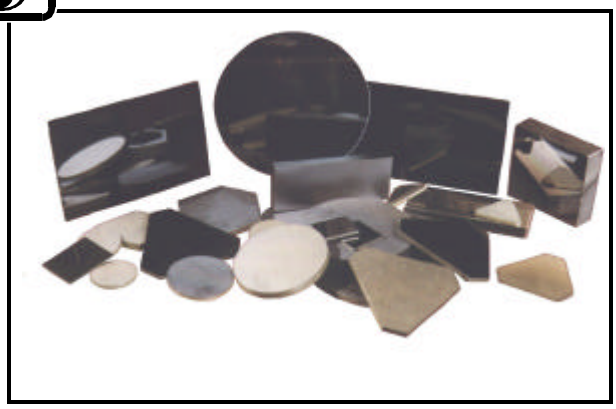
FERRITE DOMEN COMPANY



GARNETS, FERRITE SPINEL, HEXAFERRITES AND MICROWAVE CERAMICS

The company performing R&D and production of all kind of microwave garnets, spinels, hexaferrites, absorbing ferrites, and microwave ceramics used in various components of broad spectrum of radio engineering facilities such as radar antennas, telecommunication complexes including mobile satellite stations, electronic countermeasure systems, high power devices of particle accelerators, different contactless measuring/sensor instruments, the list can go on-and-on.

Microwave Materials from Ferrite Domen Company

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- **Hexaferrites**
- **High density hexaferrites**
- **High-Q microwave ceramics**
- **Thermostable microwave ceramics**

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SYMBOLS

$4pM_s$	**Saturation magnetization**	**Gauss**
DH	**FMR linewidth (3 dB)**	**Oe**
$e\ell$	**Dielectric constant**	
tgd_e	**Dielectric loss tangent**	
g_{eff}	**Landé factor**	
T_c	**Curie temperature**	**^oC**
DH_k	**Spin wave linewidth**	**Oe**
H_c	**Coercive force**	**Oe**
H_{Aeff}	**Effective anizotropy field**	**Oe**
B_r	**Remanent flux density**	**Gauss**
ρ	**Balk density**	**g/cm^3**
TKe	**Temperature coefficient of dielectric constant**	**ppm/ ^{o}C**
t_f	**Temperature coefficient of f_r**	**ppm/^{o}C**
r	**Grain size**	**mkm**
W	**Water absorbtion**	**%**

Note. DH, DH_k, $e\ell$, tgd_e **measured @ 9.4 GHz**

Yttrium garnets

Pure Yttrium garnets are the basic ferromagnetic materials for the whole series of YIG - doped compositions, see example grade.

Material grade	$4pM_s$ G ±5%	DH (-3dB) Oe no more	ε ±5%	$tg\delta_\varepsilon \cdot 10^4$ no more	g_{eff} ±3%	T_c °C nominal	DH_k Oe nominal
G-178	1780	45	15.1	2	2.00	280	1
NG-178		35					
NG-178-1		25					

YIG - Al doped

That series of microwave garnets is presented as the richest product mix by saturation magnetization values. They are most widely used in low power m-, dm-, and cm-wave devices.

Material grade	$4pM_s$ G	DH (-3dB) Oe no more	ε ±5%	T_c °C nominal	$tg\delta_\varepsilon \cdot 10^4$ no more	DH_k Oe nominal
GA-150	1500±5%	45	14.9	250	2	1.5
GA-150-1		25				
GA-140	1400±5%	45	14.8	245		
GA-140-1		25				
GA-120	1200±5%	45	14.6	230		
GA-120-1		25				
GA-110	1100±5%	45	14.5	220		
GA-110-1		25				
GA-100	1000±5%	45		210		
GA-100-1		25				
GA-90	900±5%	45	14.4	200		
GA-90-1		25				
GA-80	800±5%	45	14.2	195		
GA-80-1		25				
GA-65	650±5%	45		175		
GA-65-1		25				
GA-58	580±5%	45	14.1	165		
GA-58-1		25				
GA-48	480±5%	45	14.0	150		
GA-48-1		25				
GA-40	400±25 G	40	13.9	130		2
GA-32	320±25 G		13.8	120		
GA-20	200±25 G		13.7	100		

Note: Landé factor, g_{eff} is 2.00 for all materials of this group

Narrow Line Width Garnets

The garnets of this group feature the narrowest FMR linewidth of all YIG series. They are especially suitable for application in microwave devices (including cryogenic ones) having low losses and efficient in wide frequency and temperature ranges.

YIG - Ca doped

Material grade	$4pM_s$ G ±5%	DH (-3dB) Oe no more	ε' ±5%	T_c °C nominal	$tg\delta_\varepsilon \cdot 10^4$ no more	g_{eff} ±3%	DH_k Oe nominal
NG-195	1950	15	15.0	235	2	2.00	1
NG-190	1900		15.0	215			
NG-185	1850		14.8	215			
NG-160	1600	12	14.8	220			
NG-140	1400	10	14.5	215			
NG-120	1200		14.5	180			
NG-100	1000		14.2	170			
NG-80	800		14.1	160			
NG-52	520		13.9	120			

YIG –Ca, V doped

Material grade	$4pM_s$ G ±5%	DH (-3dB) Oe no more	ε' ±5%	T_c °C nominal	$tg\delta_\varepsilon \cdot 10^4$ no more	g_{eff} ±3%	DH_k Oe nominal
NGV-190	1900	15	14.8	215	2	2	1
NGV-160	1600	12	14.6	220			
NGV-140	1400	10	14.5	215			
NGV-120	1200		14.5	208			
NGV-100	1000		14.2	200			
NGV-80	800		14.0	190			

YIG – Gd, Al doped

The prime features of these garnets are high temperature stability of their parameters, good squareness of hystersis loop and raised threshold power. They find wide application in average and high power non-reciprocal as well as controlled microwave devices (phase shifters, switches, filter etc.).

Material grade	$4pM_s$ G ±5%	DH (-3dB) Oe no more	ε' ±5%	T_c °C nominal	H_c Oe nominal	B_r G nominal	DH_k Oe nominal	$tg\delta_\varepsilon \cdot 10^4$ no more	g_{eff} ±3%
GG-178	1780	42	15.0	280	0.55	1240	2	2	2.00
GG-160	1600	45	14.9		0.75	1120	4		
GG-120	1200	75	15.2		0.60	820	8		2.01
GG-95	940	95	15.1	255	0.70	660	10		
GG-80	800	85	14.7	240	0.55	525	9		
GG-55	550	65	14.5	180	0.55	385	8		
GG-50	490	200	14.5	205	0.65	325	21		2.03

YIG - Gd, In doped

The garnets of this group have low losses with rather high thermal stability of saturation magnetization and good threshold characteristics. They were developed for use in non-reciprocal average power devices.

Material grade	$4\pi M_s$ G ±5%	DH (-3dB) Oe no more	ε ±5%	g_{eff} ±3%	T_c °C nominal	DH_k Oe nominal	$tg\delta_\varepsilon \cdot 10^4$ no more
GI-138	**1380±5%**	**20**	**15.0**	**2.00**	**240**	**5**	**2**
GI-130	**1300±5%**	**42**	**15.1**	**2.00**	**225**	**6**	
GI-122	**1220±5%**	**20**	**14.9**	**2.00**	**220**	**3**	
GI-120	**1200±5%**	**35**	**15.0**	**2.01**	**220**	**10**	
GI-115	**1150±5%**	**35**	**15.1**	**2.00**	**230**	**7**	
GI-85	**850±5%**	**55**	**15.0**	**2.01**	**210**	**10**	
GI-63	**630±5%**	**48**	**14.6**	**2.01**	**150**	**14**	
GI-59	**590±30 Ãñ**	**90**	**14.0**	**2.01**	**210**	**2**	
GI-45	**450±25 Ãñ**	**48**	**14.5**	**2.02**	**135**	**13**	
GI-40	**400±25 Ãñ**	**95**	**14.5**	**2.03**	**160**	**13**	

YIG - for high peak power devices

The garnets of this group feature extremely good threshold characteristics.
They are used in devices that must operate at high peak power levels.

Material grade	$4\pi M_s$ G	DH (-3dB) Oe no more	ε ±5%	T_c °C nominal	DH_k Oe nominal	g_{eff} ±3%	$tg\delta_\varepsilon \cdot 10^4$ no more
GH 178	**1780±5%**	40	15.1	**280**	**6**	1.99	2
GH 128	**1280±5%**	60		**225**	**16**	2.00	
GH 120	**1200±5%**	140	15.0	**275**	**18**	2.01	
GH-90	**900±5%**		**15.5**	**280**	**14**		
GH-90-1	**650±5%**	45	**14.8**	**165**	**12**		
GH 65	**650±5%**	80	**14.7**	**150**	**16**		
GH 65-1	**650±5%**	45	**14.7**	**150**	**16**		
GH 47	**470±25 G**		**14.5**	**130**	**19**	2.00	
GH 33	**330±25 G**	160	**14.2**	**160**	**26**	2.02	

Nickel ferrite spinels

The spinels of this group feature high Curie temperature. They are widely used in resonance devices operating at cm- and mm- wave ranges.

Material grade	$4pM_s$ G ±5%	DH (-3dB) Oe no more	e ±5%	$tgd_e \cdot 10^4$ no more	g_{eff} ±3%	T_c °C nominal	H_c Oe nominal	B_r G nominal
SN-500	5000	150	13.4	6	2.11	345	1.5	3500
SN-475	4750	205	13.2	4	2.14	400	2.0	3150
SN-475-1	4750	170	13.7	5	2.11	325	1.0	2850
SN-450	4500	215	13.5	6	2.13	430	1.0	3100
SN-450-1	4500	100	14.5	5	2.05	280	≤ 0.4	≥ 2800
SN-400	4000	240	13.6	4	2.12	480	1.9	2400
SN-350	3500	360	13.2	6	2.21	540	3.8	2340
SN-315	3150	300	13.7	4	2.17	560	3.0	2000
SN-285	2850	300	13.7	5	2.20	550	3.0	1200
SN-250	2500	265	13.7	5	2.20	530	3.5	1100
SN-230	2300	205	13.2	6	2.20	500	3.5	900

Nickel ferrite spinels, hot-pressed

The hot-pressed Nickel spinels are characterized by very low porosity and high thermal conductivity of ferrite article body. They are recommended for use in microstrip microwave devices as well as high power waveguide ones.

Material grade	$4pM_s$ G ±5%	DH (-3dB) Oe no more	e ±5%	$tgd_e \cdot 10^4$ no more	g_{eff} ±3%	T_c °C nominal	H_c Oe nominal	B_r G nominal	DH_k Oe nominal
SH-520	< 5200	95	14,3	2	2.08	355	1.0	3200	> 6
SH-520-1		115	14.2	4	2.10	365	1.0	3200	6
SH-500	5000	130	14.0		2.10	345	1.4	3000	12.5
SH-495	4950	170	13.9		2.09	420	1.9	3200	
SH-495-1	4950	90	14.4	2	2.08	385	1.1	3400	> 9
SH-435	4350	140	13.9	6	2.10	440	4.0	2300	---
SH-315	3150	220	13.7	3	2.17	560	4.0	1350	---
SH-295	2950	250	13.9	5	2.17	550	3.2	1600	20
SH-230	2300	140	13.5		2.26	500	10.8	900	

Lithium ferrite spinels

Spinels of this group feature low non-resonant magnetic losses, high remanent flux density, and high Curie temperature.

They are mostly used in non-resonant controlled devices of low power levels at cm- and mm- wave ranges (phase shifters, switches etc.).

Material grade	$4\pi M_s$ G ±5%	ΔH (-3dB) Oe no more	ε ±5%	$tg\delta_\varepsilon \cdot 10^4$ no more	g_{eff} ±3%	T_c °C nominal	H_c Oe nominal	B_r G nominal
SL-475	4750	300	14.4	6	2.06	450	1.1	3250
SL-470	4700	200	14.7	5	2.06	440	≤ 0.6	≥ 3000
SL-450	4500	335	15.1	5	2.02	520	1.1	2900
SL-420	4200	150	14.6	5	2.05	310	≤ 0.4	≥ 2800
SL-400	4000	480	15.0	6	2.06	570	1.4	2600
SL-340	3400	600	15.0	5	1.98	580	2.4	2400
SL-315	3150	505	15.5	4	2.05	560	1.5	2150
SL-250	2500	500	15.4	5	1.98	550	1.91	1750
SL-225	2250	350	16.3	5	2.04	430	1.1	1650
SL-210	2100	335	16.3	7	2.00	430	1.2	1500
SL-200	2000	430	16.2	5	2.02	440	1.3	1450
SL-187	1870	340	16.0	8	2.04	300	≤ 1.4	≥ 1200
SL-155	1550	420	16.6	5	2.05	390	1.1	1100

Manganese ferrite spinels

These materials are applied where it is necessary to have low magnetic and dielectric losses.

Material grade	$4\pi M_s$ G ±5%	ΔH (-3dB) Oe no more	ε ±5%	$tg\delta_\varepsilon \cdot 10^4$ no more	g_{eff} ±3%	T_c °C nominal	H_c Oe nominal	B_r G nominal
SM-210	2100	320	13.0	8	2.06	360	2.0	---
SM-190	1900	530	11.7	4	---	300	4.0	---
SM-170	1700	330	12.3	6	---	260	5.5	1030
SM-160	1600	570	12.5	2.5	2.10	350	4.5	---
SM-145	1450	150	12.0	4	2.02	140	1.0	250
SM-105	1050	360	10.5	2.5	1.98	330	1.0	---
SM-88	880	90	10.2	20	---	90	0.9	400
SM-78	780	210	10.0	4.0	---	160	2.0	---
SM-70	700	185	9.5	2.5	---	140	2.0	560

Hexaferrites occupy a special place among the microwave magnetic materials. They feature high magnetic anisotropy (17 kOe) and are recommended for the use in millimeter wave isolators and circulators workable at frequencies 10 GHz through 100 GHz. Hexaferrites permit to create miniaturized yet discrete microwave devices that do not require a permanent biasing magnets in the component package.
High-density hexaferrites are ideal for MIC application and microstrip mm-wave devices.

Hexaferrites

Material grade	H_{aeff} kOe ±5%	$4pM_s$ G ±5%	DH (-3dB) kOe no more	e_t ±5%	$tgd_e \cdot 10^4$ no more	T_c °C nominal	H_c kOe nominal	r g/cm^3
H 6	6	2850	3.0	13	10	450	0.07	4.20
H 9	9	3000	3.5		8	475	0.15	4.10
H12	12	3150				520	0.4	
H15	15	2900				400	1.5	
H18	18	2200			10	435	2.5	
H21	21	1800	3.0		20	400	2.8	
H23	23	1900	3.5	14	10	310	3.0	
H25	25	1700				300		
H28	28	1400				270		
H31	31	1500	3.0	15	20	255		4.40
H33	33	1600				237		
H35	35	1400	3.5	15		215		

High density hexaferrites

Material grade	H_{aeff} kOe ±5%	$4pM_s$ G ±5%	DH (-3dB) kOe no more	e_t ±5%	$tgd_e \cdot 10^4$ no more	T_c °C nominal	H_c kOe nominal	r g/cm^3
HD 6	6	3400	2.5	17	10	450	0.05	4.90
HD11	11	3700				507	0.1	
HD16	16	3300	2.0			465	1.5	
HD17	17	4300		20	8	470	0.6	5.20
HD19	19	3500		17	6	400	2.5	4.90
HD20	20	2400			10	400	0.6	
HD22	22	3000	1.5	18	8	340	3.0	4.95
HD28	28	2100		17	10	270		
HD30	30	2000				260		
HD32	32	1800				250		
HD33	33	1700				240		

Ferrite Domen Company presents the wide choice of high-Q ceramics with dielectric constant 4 up to 140 for microwave products operational in wide frequency and temperature ranges.

High-Q microwave ceramics

These ceramic materials give wide choice of applications addressing everything from substrates to microwave ferrite devices such as circulators, isolators, phase shifters. Dielectric substrates are used in hybrid IC, filters, delay lines, etc.

Material grade	Composition	ε'	ρ g/cm^3	*TKe* ppm/ ^{o}C	W % no more	tgδ$_\varepsilon$ ·10^4 no more
6.5 F	Mg-Si-O	6.5±0.3	2.8	+107	0.2	3
7.4 MTK	Mg-Si-Ti-O	7.4±0.2	3.0	+100	0.1	
8 ML	Mg-Al-O	8.5±0.3	3.3	+9	0.2	
9.5 MTK	Mg-Si-Ti-O	9.5±0.3	3.2	+100	0.1	2
10.3 MTK	Mg-Si-Ti-O	10.3±0.3	3.3	+100		
12 MTK	Mg-Si-Ti-O	12±0.4	3.3	+100		
13 MT	Mg-Ti-O	13±0.5	3.4	+100		
15 MT	Mg-Ti-O	15±0.5	3.5	+100		
16 MT	Mg-Ti-O	16±0.5	3.6	+100		
18 MCT	Mg-Ca-Ti-O	18±0.5	3.5	-70		
20 MCT	Mg-Ca-Ti-O	20±1.0	3.5	-130		3
30 MCT	Mg-Ca-Ti-O	30±1.5	3.6	-370		
40 MCT	Mg-Ca-Ti-O	40±2.0	3.65	-580		
50 MCT	Mg-Ca-Ti-O	50±2.5	3.68	-730		
80 MCT	Mg-Ca-Ti-O	80±4.0	3.70	-1050		
100 MCT	Mg-Ca-Ti-O	100±5.0	3.75	-1120		
120 MCT	Mg-Ca-Ti-O	120±6.0	3.80	-1170		
140 MCT	Ca-Ti-O	140±7.0	3.85	-1200		

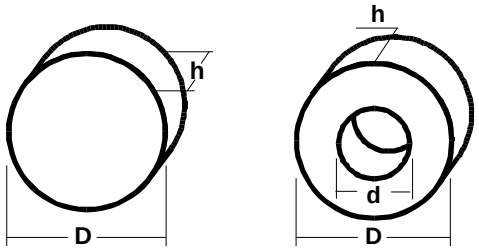
Thermostable microwave ceramics

This sort of ceramics was developed for realization of dielectric resonators featuring high quality factor (Q) and excellent stability of temperature coefficient of frequency. These devices are widely used in low-noise frequency converters of SATCOM systems, in detectors of radar radiation, in dielectric high-stable oscillators of communication equipment, in microwave filters, generators of microwave signals, etc.

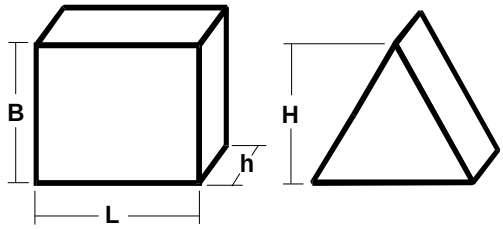
Material grade	*e*ℓ *)		*tgd$_e$ ·10^4 *)*	t_f ppm/ ^{o}C in temperature range (20-60) ^{o}C	ρ g/cm^3		W % no more
	nominal	max. deviation %			nominal	max. deviation	
KT-37	34…40	± 2	3	0 ± 9	4.8	± 0.3	0.1
KT-75	70…80		8		5.5		
KT-90	80…90		10	0 ± 15	5.0		

Note. *- measured at 4.5 GHz

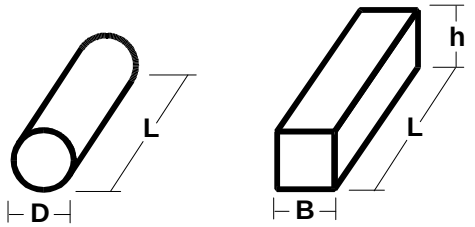
Disks and Rings



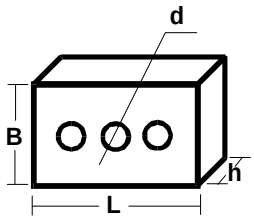
Plates and triangles



Rods and bars



Multiple-aperture prisms



Dimensions of garnets, ferrite spinels and ceramics, mm

	Disks	Plates and triangles	Rods and bars	Rings	Multiple-aperture prisms*)
D	**10…120**		**5…40**	**5…100**	
L		**15…120**	**20…120**		**7; 14**
B		**5…60**	**5…30**		**3.5; 4.5**
H		**≤90**			Calculated value **(4…10)**
h	**3…10**	**3…10**	**5…15**	**2.5…15**	
d				**2…70**	**1…1.5**

Note. *) Ceramics

Dimensions of hexaferrites, mm

	Disks	Plates
D	**20…45**	
L		**≤40**
B		**≤35**
h	**2.5…4**	**2.5…4**

Standard surface finish of parts: ± 0,02 mm
Standard surface roughness: Ra ≥ 0,6 mm
Fabrication of customized parts is being provided.