

Dr.-Ing. Guido Falk

Einführung



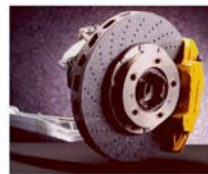
Ballisticschutzsystem, z.B. für Radfahrzeuge TPz (Rheinmetall)



Keramik-Bremse (SGL Carbon)

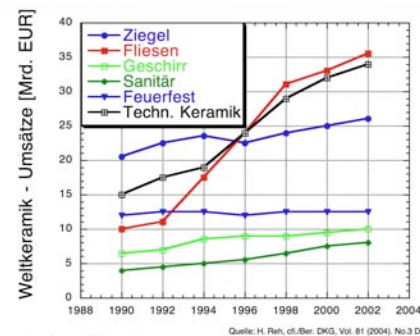
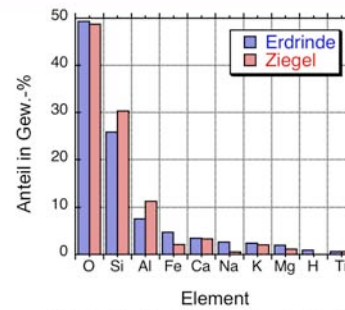
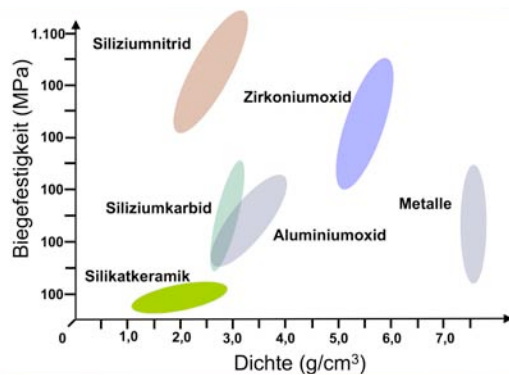


Hitzeschutzschild Space Shuttle

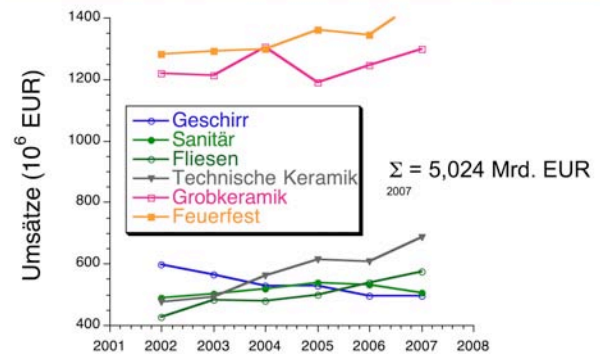


	Keramik	Metall	Polymere
Härte	↑	↓	↓
E-Modul	↑	↑	↓
Hochtemperaturfestigkeit	↑	↓	↓
Thermische Ausdehnung	↓	↑	↑
Duktilität	↓	↑	↑
Korrosionsbeständigkeit	↑	↓	↓
Verschleißbeständigkeit	↑	↓	↓
Elektrische Leitfähigkeit	↓	↑	↓
Dichte	↓	↑	↓
Wärmeleitfähigkeit	↓	↑	↓

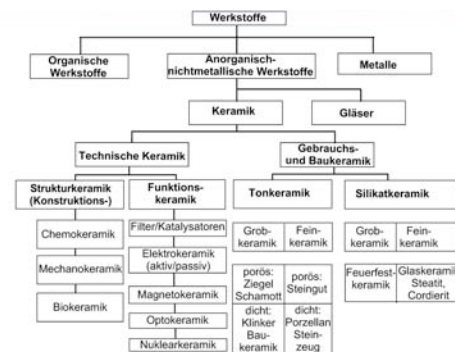
↑ Tendenz zu hohen Werten ↓ Tendenz zu niedrigen Werten



Quelle: H. Reh, cit. Ber. DKG, Vol. 81 (2004), No.3 D28 D32



Einteilung keramischer Werkstoffe



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Silikatkeramik

Porzellan
 Steatit
 Cordierit
 Mullit
 ...

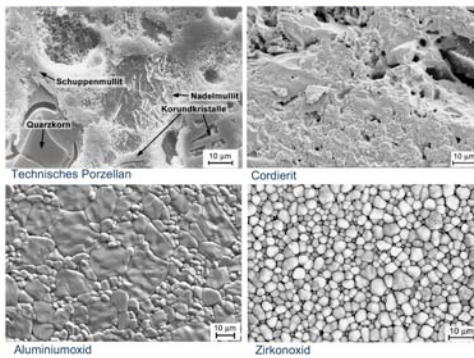
Oxidkeramik

Aluminiumoxid
 Magnesiumoxid
 Zirkonoxid
 Aluminiumtitanat
 ...

Nichtoxidkeramik

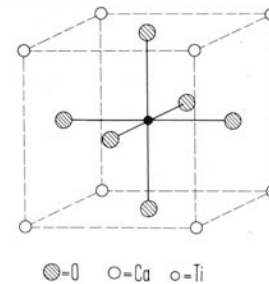
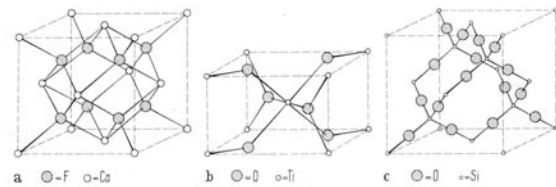
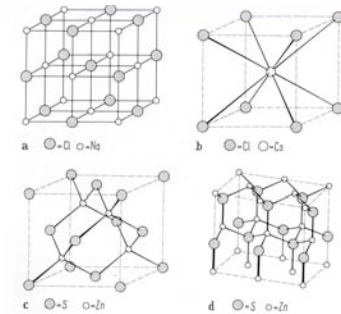
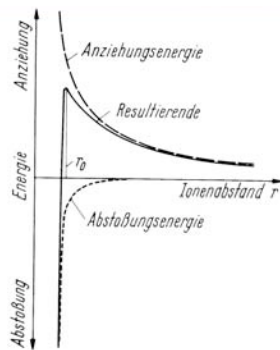
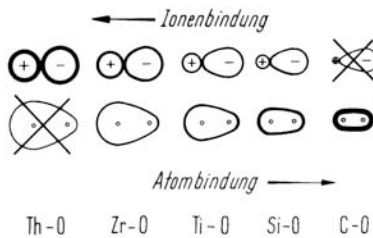
Siliziumkarbid
 Siliziumnitrid
 Aluminiumnitrid
 Borkarbid
 ...

Strukturen keramischer Werkstoffe



Kristallsystem	einfach	basisflächen-zentriert	raum-zentriert	flächen-zentriert
kubisch $a = b = c$ $\alpha = \beta = \gamma = 90^\circ$				
tetragonal $a = b \neq c$ $\alpha = \beta = \gamma = 90^\circ$				
orthorhombisch $a \neq b \neq c$ $\alpha = \beta = \gamma = 90^\circ$				

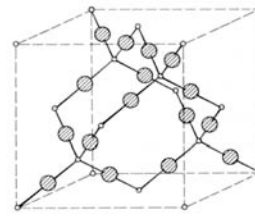
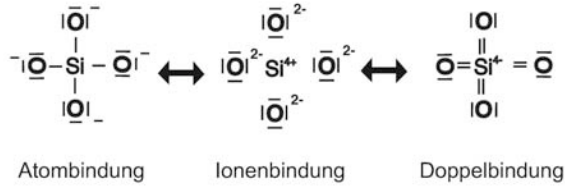
rhomboedrisch $a = b = c$ $\alpha = \beta = \gamma \neq 90^\circ$			
hexagonal $a = b \neq c$ $\alpha = \beta = 90^\circ$ $\gamma = 120^\circ$			
monoklin $a \neq b \neq c$ $\alpha = \beta = \gamma = 90^\circ$ $\beta \neq 90^\circ$			
triklin $a \neq b \neq c$ $\alpha \neq \beta \neq \gamma$			



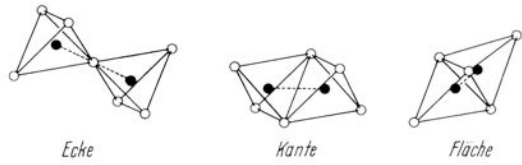
Bezeichnung	Elementarzelle		Zur Kennzeichnung sind notwendig
	Achsen	Winkel	
triklin	$a \neq b \neq c$	$\alpha \neq \beta \neq \gamma$	$a, b, c; \alpha, \beta, \gamma$
monoklin	$a \neq b \neq c$	$\alpha = \beta = \gamma = 90^\circ \neq \beta$	$a, b, c; \beta$
orthorhombisch	$a \neq b \neq c$	$\alpha = \beta = \gamma = 90^\circ$	a, b, c
hexagonal/trigonal	$a = b \neq c$	$\alpha = \beta = 90^\circ, \gamma = 120^\circ$	a, c
tetragonal	$a = b \neq c$	$\alpha = \beta = \gamma = 90^\circ$	a, c
rhomboedrisch	$a = b = c$	$\alpha = \beta = \gamma \neq 90^\circ$	$a; \alpha$
kubisch	$a = b = c$	$\alpha = \beta = \gamma = 90^\circ$	a

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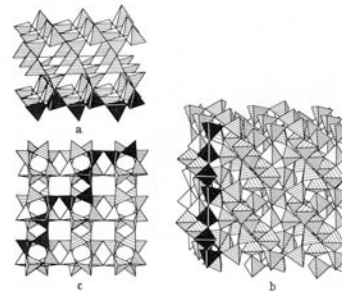
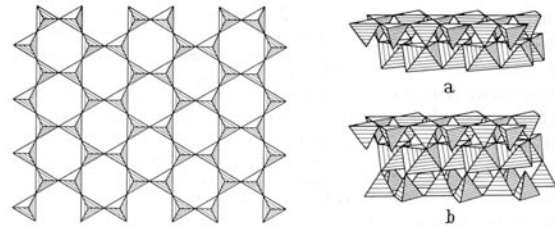
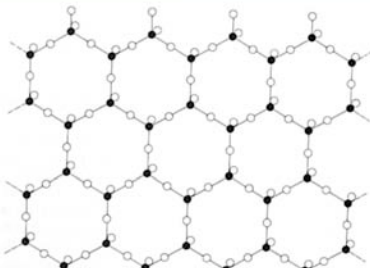
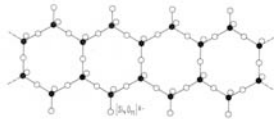
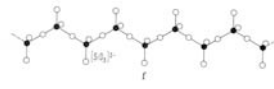
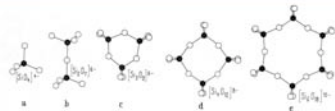
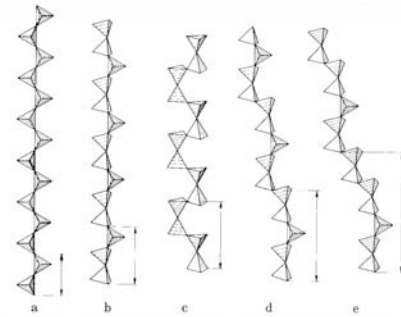
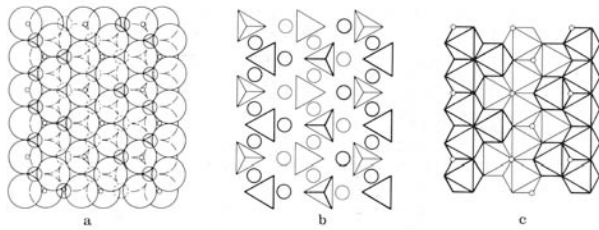
Systematik der Silikatkeramiken



(● = Si , ○ = O)



Typ	Form	Dimen- sionszahl	Silicium- anion	O: Si- Verhältnis F	Beispiel	
					Name	Formel
Tetraeder	einfach	0	[SiO ₄] ⁴⁻	4,0	Forsterit	Mg ₂ [SiO ₄]
	doppelt	0	[Si ₂ O ₇] ⁶⁻	3,5	Rankinit	Ca ₂ [Si ₂ O ₇]
Ringe	Dreiering, einfach	0	[Si ₃ O ₉] ⁶⁻	3,0	Bastnaesit	Ba ₂ T[Si ₃ O ₉]
	Sechsering, einfach	0	[Si ₆ O ₁₈] ¹²⁻	3,0	Beryll	Al ₂ Be ₂ [Si ₆ O ₁₈]
	Sechsering, doppelt	0	[Si ₁₂ O ₃₆] ²⁴⁻	2,5	Milarien	K ₂ Ca ₂ AlBe ₂ [Si ₁₂ O ₃₆] · 1/2 H ₂ O
Ketten	einfach	1	[SiO ₃] ²⁻	3,0	Enstatit	MgSiO ₃
	doppelt	1	[Si ₂ O ₇] ⁶⁻	2,75	Trondhjemit	Ca ₂ Mg ₂ [Si ₂ O ₇] _{1-1/2} (OH) ₁
Schichten	einfach	2	[Si ₂ O ₅] ⁴⁻	2,5	Kaolinit	Al ₂ [Si ₂ O ₅](OH) ₄
Gerüste	—	3	[SiO ₂]	2,0	Quarz	SiO ₂



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