学術情報

GC CORPORATION

Physical Properties of New High-strength Lithium-disilicate Press Ceramics

#0612

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Objectives

The purpose of this study was to explore the relationship between bending strength and crystallographic structure of new high-strength lithium-disilicate (LDS) press ceramics. High-strength press ceramics are very useful materials in clinical restorative situation due to their aesthetics and biological compatibility. However, detailed mechanism for high-strength has not been analyzed sufficiently. Therefore we conducted a study to analyze the mechanism and understand the characteristics of high-strength press ceramics.

Methods

Materials

Specimens were prepared using dedicated investment material following manufacturer instructions.

Table 1 Materials

Code	Material (Crystal system)	Lot No.	Product name (Manufacturer)	Investment	Press furnace (Manufacturer)
GCPS05	High-strength press ceramics (LDS)	1504291	initial LiSi Press (GC)	Dedicated investment (Prototype)	PANAMAT PRESS (GC)
EM	Press ceramics (LDS)	T30193	IPS e.max Press (Ivoclar Vivadent)	IPS PressVEST Speed	Programat EP5000 (Ivoclar Vivadent)
VP	Press ceramics (LDS)	121401	Vintage LD Press (Shofu)	Ceravety Press & Cast	PANAMAT PRESS
IP	Press ceramics (Leucite)	1307181	initial PC (GC)	GC Initial Press Vest	PANAMAT PRESS

Test methods

●Biaxial Flexural Strength Test (BFS)

For BFS test, mirror-polished samples with a diameter of 15.2 mm and a thickness of 1.2 mm were prepared in accordance with ISO 6872-2008 " Dentistry-Ceramic materials " . Bending test was conducted using universal testing machine AG-50KG (Shimadzu) with a cross-head speed of 1.0 mm/min (n=10). For the support of the test specimen, three hardened steel balls pointed 120° apart on a support circle were provided. Data were statistically analyzed by Tukey's test after one-way ANOVA. (p<0.01).

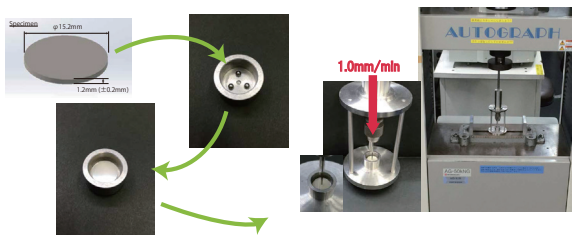


Fig. 1 Scheme of BFS

●X-ray Diffraction Analysis (XRD)

To determine the crystal structures, 1 mm-thick, mirror polished samples were analyzed by XRD using Empyrean (PANalytical).

X-ray diffractometer
from Empyrean PANalytical Inc. HP

●Scanning Electron Microscope Observation (SEM)

To characterize the microstructure of each material, mirror-polished and then etched with HF solution samples were observed by SEM (SU-70, HITACHI).

Scanning Electron Microscope SU-70
from Hitachi High-Technologies Corp. HP

Results and Discussion

●Biaxial Flexural Strength Test (BFS)

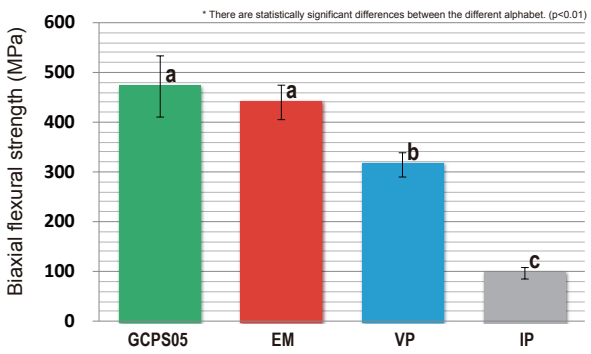


Fig. 2 Comparison of biaxial flexural strength

BFS of "GCPS05" was significantly higher than "IP", equal to "EM" and higher than "VP" (Tukey's test after one-way ANOVA, p<0.01).

●X-ray Diffraction Analysis (XRD)

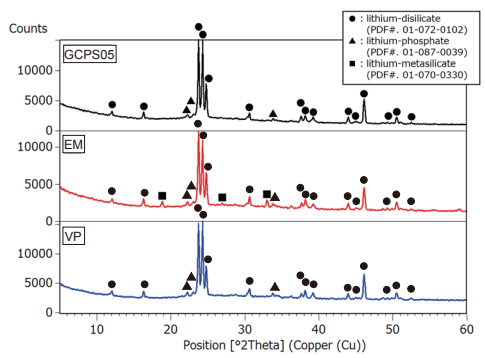
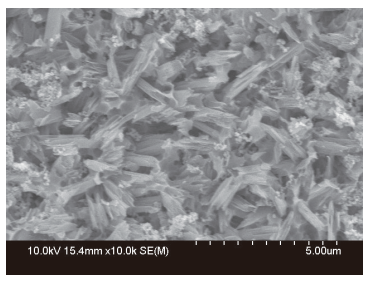


Fig. 3 Comparison of crystal systems

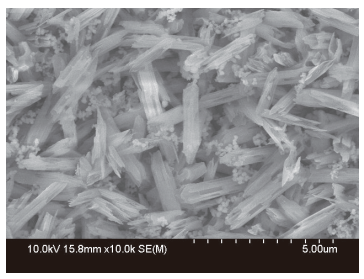
XRD measurement revealed fine columnar crystal is LDS. GCPS05 and VP included mainly LDS. EM included not only LDS but also LMS (lithium-metasilicate).

●Scanning Electron Microscope Observation (SEM)



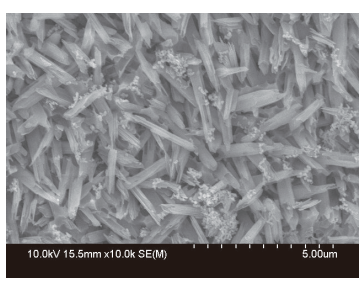
GCPS05
(x 10,000)

<Crystal size>
major axis : approx. 1.5 μm
minor axis : approx. 0.5 μm



EM
(x 10,000)

<Crystal size>
major axis : approx. 3.0 μm
minor axis : approx. 0.8 μm



VP
(x 10,000)

<Crystal size>
major axis : approx. 3.0 μm
minor axis : approx. 0.5 μm

Fig. 4 Comparison of crystal shape and size

SEM observation demonstrated high levels of fine columnar crystals existing in LDS press ceramics. Crystal size was different for each product.

Conclusion

Even if the kind of crystal is same, BFS may be different. It is thought that BFS is influenced by volume of crystal. Regarding GCPS05, it is suggested that as a result of having reduced columnar crystal size LDS, crystal structure is highly dense, and may be one factor creating high BFS greater than 450MPa.