

Characteristics of polymer based CAD/CAM blocks for permanent restorations

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Objective

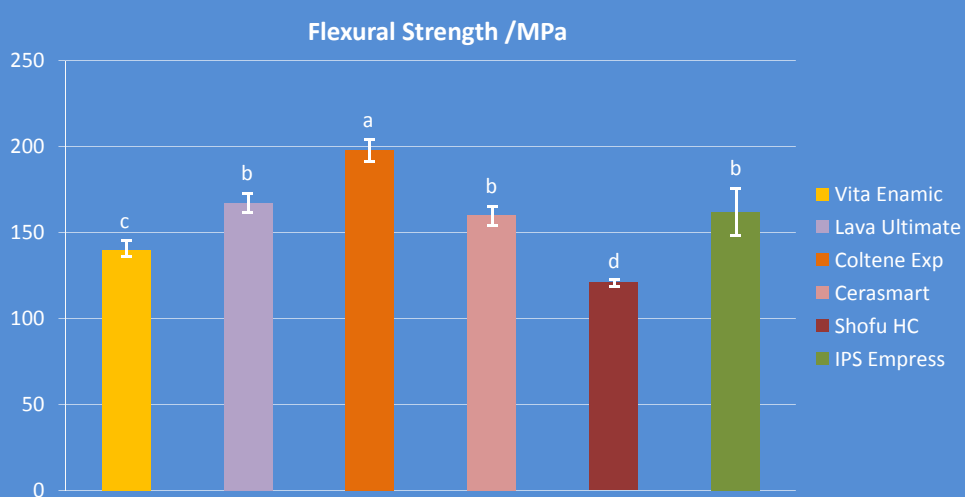
Analysis of hybrid and polymer based CAD/CAM blocks with respect to mechanical strength, water uptake and filler load. As reference concerning mechanical strength and modulus of elasticity, a Leucite ceramic, IPS Empress CAD (IvoclarVivadent), was selected. As a hybrid material Vita Enamic (Vita Zahnfabrik) and as polymer based materials Lava Ultimate (3M ESPE), Coltene Experimental (Coltene AG), Cerasmart (GC Corporation) and HC (Shofu Block) were selected.

Methods

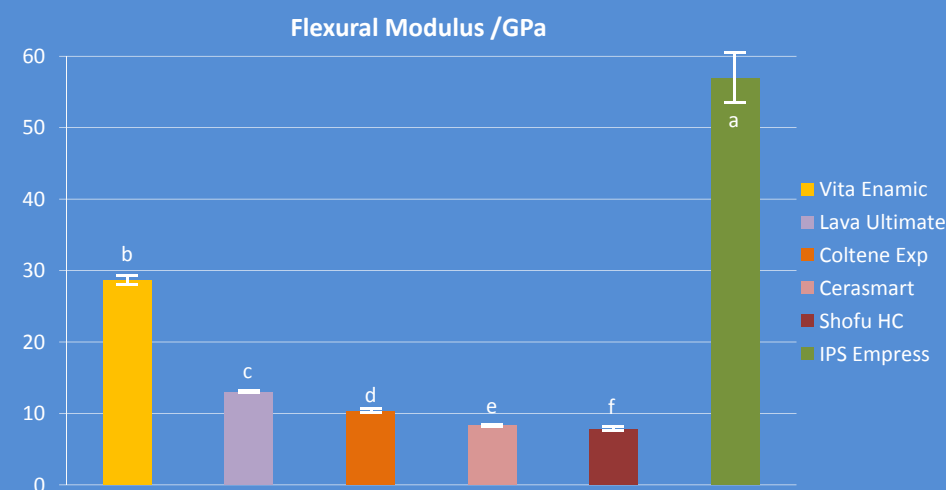
The samples were cut wet from 14L sized blocks with an Isomet 1000 diamond saw. Flexural strength and modulus of elasticity: Sticks with a dimension of 1x1x18mm were prepared. The sticks were stored in water for 24h at 37 °C. After storage a three point bending test (Zwick Z020, crosshead speed 0.5mm/min, span width 10 mm, n=7) was done. Data were analyzed with a one way ANOVA (p<0.05). Water uptake was tested with discs (discs from block size 14L, thickness 1mm, n=5), according to ISO 4049. Data were analyzed with a one way ANOVA (p<0.05). Filler content was determined (n= 3) by burning the organic components at a temperature of 700°C in the presence of air.



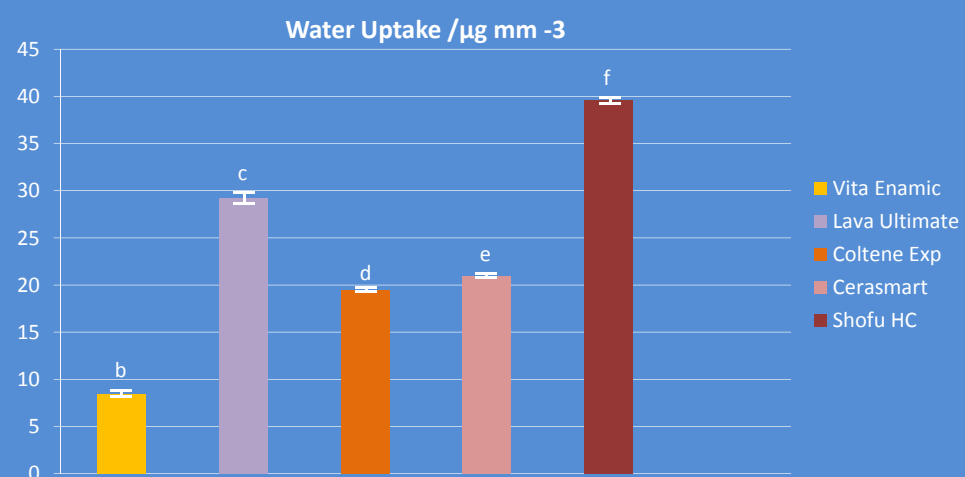
	Flexural Strength /MPa	Flexural Modulus /GPa	Water Uptake / $\mu\text{g mm}^{-3}$	Filler Weight /weight%
Vita Enamic	140 \pm 10 ^c	28.6 \pm 1.3 ^b	8.4 \pm 0.7 ^a	86.8 \pm 0.0
Lava Ultimate	167 \pm 12 ^b	12.9 \pm 0.4 ^c	29.2 \pm 1.2 ^d	71.9 \pm 0.1
Coltene Experimental	198 \pm 14 ^a	10.3 \pm 0.5 ^d	19.5 \pm 0.4 ^b	70.7 \pm 0.3
Cerasmart	160 \pm 12 ^b	8.3 \pm 0.3 ^e	21.0 \pm 0.4 ^c	64.1 \pm 0.0
Shofu HC	121 \pm 4 ^d	7.7 \pm 0.6 ^f	39.6 \pm 0.6 ^e	61.4 \pm 0.1
IPS Empress CAD	162 \pm 29 ^b	56.9 \pm 6.8 ^a	not applied	not applied



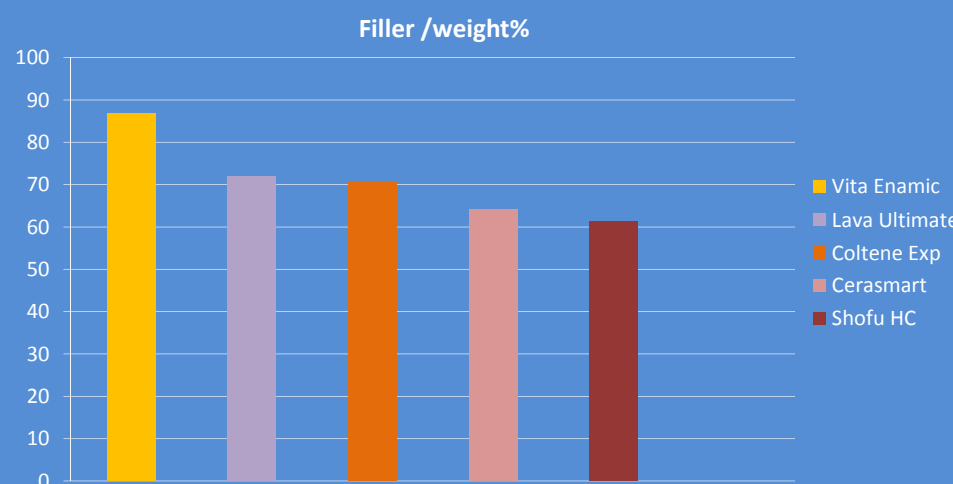
Flexural strength measurements show similar or better values for three composite materials compared to the pure ceramic material IPS Empress. The values for Vita Enamic are significant below IPS Empress, which can be an indication that the mechanical strength for Vita Enamic is mainly generated by the ceramic part of the material.



Flexural modulus of the pure ceramic material IPS Empress is clearly the highest, followed by the hybrid material Vita Enamic. All composite materials are in the range of light cured filling materials. It is discussed controversially what the ideal flexural modulus is. For veneers, for example, it is better to have a modulus below dentine. If it is higher, as in the case of ceramics, debonding or fractures can occur.



Water uptake is clearly the lowest of Vita Enamic. Coltene Exp and Cerasmart are in the range of common light cured filling materials. Lava Ultimate and Shofu HC have a relatively high water uptake, but is below 40 $\mu\text{g mm}^{-3}$, which is the threshold according ISO 4049 for light cured filling materials. Water uptake can be generated by voids, interface between resin and filler and by the resin matrix itself. If the water uptake is generated by the resin matrix only, the water uptake correlates to the expansion of the material.



The filler weight was not judged statistically. It only shows the value of inorganic ingredients of the material. With 87 % Vita Enamic has the highest inorganic portion. Shofu HC shows the lowest portion of inorganic filler. More important would be to know the volume percentage of the fillers, because the organic matrix influences the water uptake. If similar resin matrices with similar water uptake are used, water uptake is a rate for the volume percentage of filler and resin.

Conclusion

Polymer based composite blocks for permanent restorations show equal or better mechanical strength than an established Leucite ceramic. Low flexural modulus could be a benefit for a full crown on tooth or implant. The water uptake of Shofu HC fulfills the ISO 4049 requirements, but seems to be very high for an Inlay preparation. Further investigations have to prove whether restorations made from polymer based CAD/CAM blocks are an alternative to ceramics.

Addendum

12th of June 2015 3M ESPE withdrew the indication crown for Lava Ultimate because of loss of restorations. It seems that the reason is not a problem of the material. Investigations are running to evaluate whether adhesion is influenced by the luting / cementing protocol.