SCIENTIFIC REPORT

x-tra base – Vickers hardness and modulus of elasticity

VOCO GmbH, Knowledge Communication Department

Anton-Flettner-Str. 1-3
27472 Cuxhaven, Germany

Tel.: +49 (0)4721-719-1111
Fax: +49 (0)4721-719-109

info@voco.de
www.voco.dental

VOCO's x-tra base is a flowable filling composite for the bulk fill technique. It can be applied in 4 mm layers, offers functional aesthetics and the required physical properties for permanently marginal tight and intact restorations. In the present study [1], Ilie *et al.* investigated different physical properties of x-tra base and other bulk fill composites. This scientific report presents the results of the Vickers hardness and modulus of elasticity.

Aim of the study

Ilie *et al.* investigated four different flowable bulk fill composites with regard to the curing depth, mechanical hardness as well as the modulus of elasticity, a measure of the deformation properties under chewing load of a cured restoration, at the University of Munich. Furthermore, three different light curing protocols for the curing of the composites have been used in this study, in order to get information about the appropriate type of lamp, transmission of the light output as well as the ideal curing time. [1]
This scientific report presents the results regarding the Vickers hardness as well as the modulus of elasticity. The results for the curing depth in general and the dependent light curing protocols will be presented and discussed in a separate scientific report.

Study design

Four flowable bulk fill composites have been examined; x-tra base (VOCO), Venus Bulk Fill (Heraeus Kulzer), Filtek Bulk Fill (3M ESPE) and Surefil SDR (Dentsply). In order to determine the physical properties, test specimens have been produced in a cylindrical cavity (in a human molar with a depth of 6 mm and width of 5 mm). The curing has been carried out with a commercial LED polymerisation lamp (VALO, Ultradent Products Inc., Modus „Standard“, 20 s, 1000 mW/cm^2) and according to the manufacturer's instructions. The Vickers hardness was determined computer-aided with a hardness impressing body in intervals of 0.2 mm. The curing depth was then calculated from the Vickers hardness. The hardness of the surface has been taken as reference and was compared with the hardness in the depths 0.2 mm, 2 mm, 4 mm and 6 mm. The modulus of elasticity, stated in GPa, was also calculated from the Vickers hardness. The slope of the tangent of the depth curve of the Vickers hardness at the beginning of the measurement at maximum load was used for this purpose.

Results

The results of the surface hardness according to Vickers are shown in figure 1. x-tra base proofs excellent physical properties in this study and has the highest surface hardness of all four tested materials. Both SDR and Venus, or Filtek Bulk Fill only reach 64 %, 52 % and 62 % corresponding to the x-tra base surface hardness in the measurements.

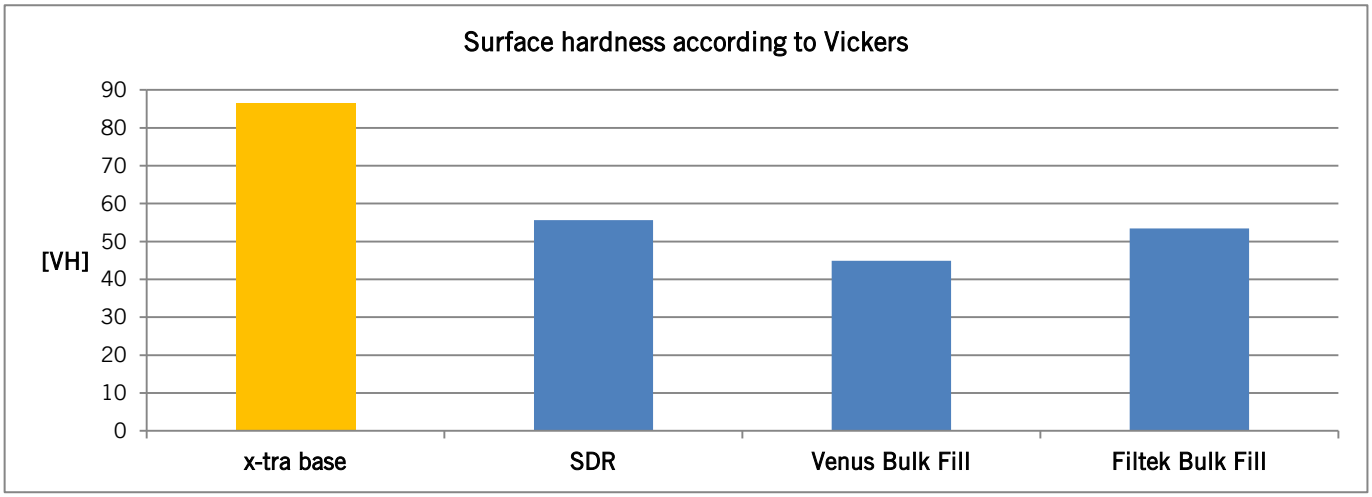

Figure 1: Surface hardness of the four tested bulk fill materials according to Vickers

It is well known that the hardness of a material alone is not decisive for its performance. Another important parameter is the modulus of elasticity. It describes the inner mobility or flexibility of a cured restoration, meaning to what extent the material in the cavity can absorb, process and handle the mobility and the associated tensile and compressive forces of the dental hard tissue. The modulus of elasticity of dentin is about 20 GPa[2]. Therefor the aim of each material should be to possess a tooth-like modulus of elasticity. Figure 2 shows the modulus of elasticity of the four examined bulk fill materials compared to dentin.

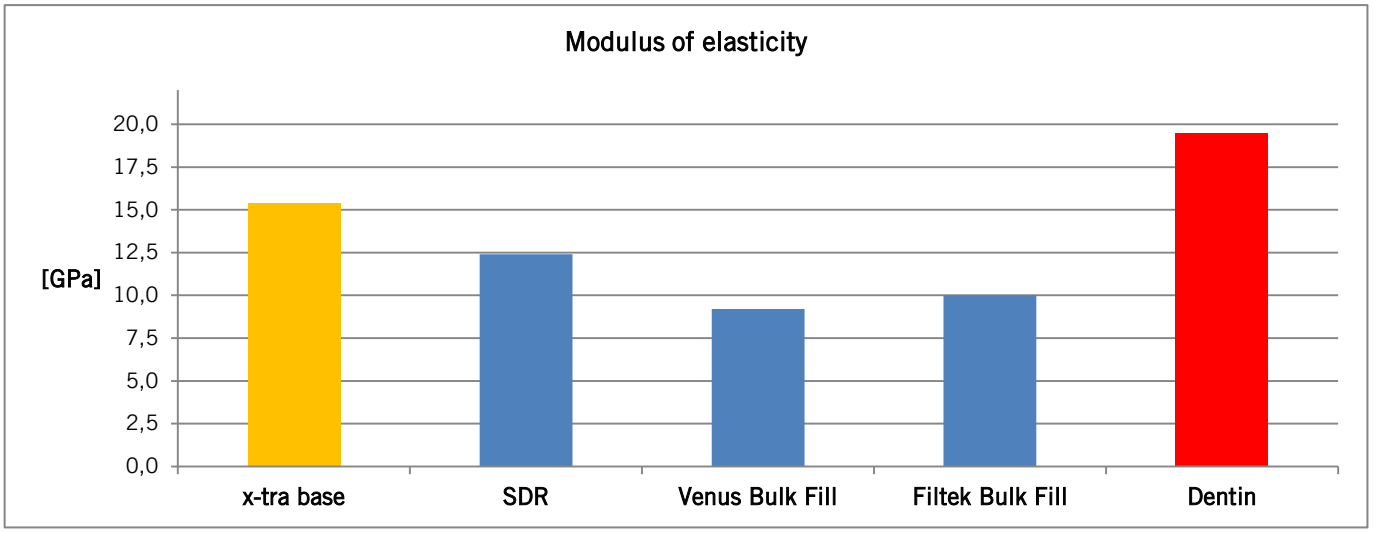

Figure 2: Modulus of elasticity of the four examined bulk fill materials in a depth of 2 mm of the restoration, as well as dentin after Swain *et al.*[2]

x-tra base performs excellently in comparison to the other bulk fill materials in this study, too. Venus Bulk Fill and Filtek Bulk Fill have a very low modulus of elasticity, which does not exceed 10 GPa. x-tra base has a modulus of elasticity of approx. 15 GPa and thus is only slightly below dentin's modulus of elasticity. So x-tra base is the most tooth-like of the four tested bulk fill materials.

Conclusion: x-tra base convinces with its physical properties in this study. At the same time, it also shows the most tooth-like behaviour compared to the other tested bulk fill materials. Therefore, x-tra base once again is a guarantor for stable and long-term intact restorations.

[1] Ilie N, Stark K: Effect of different curing protocols on the mechanical properties of low-viscosity bulk-fill composites, *Clin. Oral Invest.*, 4, **2014**.

[2] Poolthong S, Mori T, Swain MV: Determination of elastic modulus of dentin by small spherical diamond indenters, *Dental Materials Journal*, 20(3), **2001**.