

## x-tra base – Creep and permanent set

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Dental composite materials which are indicated for the placement of a bulk restoration have to meet special requirements. In addition to a 4 mm depth of cure, their mechanical strength, as a base restoration, must be sufficient to withstand the masticatory forces which occur daily in the mouth. This is in spite of the occlusal covering with a layer of a universal composite, which is necessary (as a minimum). Creep and permanent set, which describe the volume change and deformation caused by repetitive occlusal pressure, are suitable parameters for defining the long-term strength of bulk restoratives. The degree of deformation under pressure was examined by El-Safty et al. at the University of Manchester using four bulk restoratives.<sup>[1]</sup>

Creep and permanent set describe the deformation of materials under pressure. When a force acts on a body, it initially causes compression. The extent of this compression is partially described by the modulus of elasticity. After the initial fast compression, a further slow compression takes place over the subsequent seconds to hours. This compression is accompanied by creep processes within the composite. In some areas, the spatial structure is reorganised in order to compensate for local load peaks.

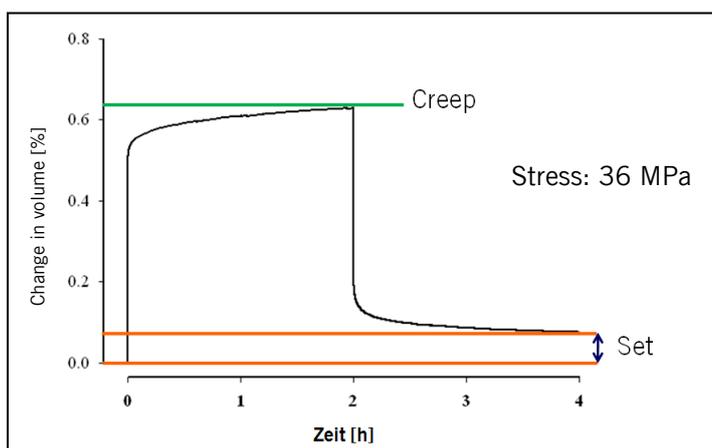


Figure 1: Measurement of creep and permanent set

As soon as the force acting on the body is removed, a reverse process takes place. Within a very short time there is an expansion, which already leads to a recovery of 80 – 90 %. Subsequently, a further slower relaxation takes place, but even after this relaxation period, the original volume is not fully restored. This difference is known as the permanent set. It describes the inelastic deformation, and is therefore of great importance especially for posterior restorations. If a material cannot withstand daily masticatory loads, deformations on the occlusal surface will occur over time. This, of course, has an effect on the occlusion, and deformations can thus lead to quite serious problems. Creep needs to be minimised in order to ensure long-term dimensional stability. Dental materials are not usually subjected to

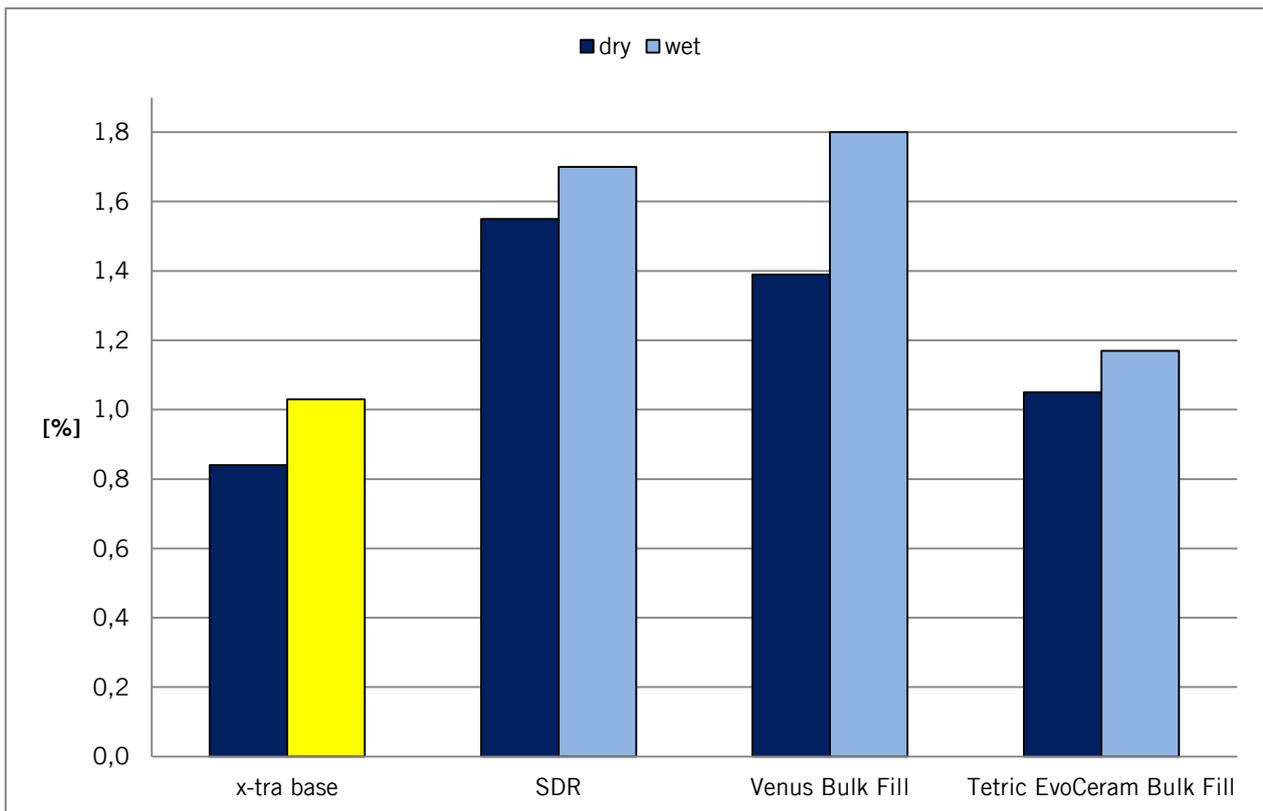
pressure loading over long periods of time, but rather short-term loads during mastication. However, even these brief loads lead to dimensional changes. A comparable example, familiar to everyone, is the formation of ruts on road surfaces

## Experimental set-up

Cylindrical test specimens (6 mm long, 4 mm in diameter) were made and stored at 37°C for 24 hours before measurement, in dry (group 1) or wet (group 2) conditions. The cylinders were then loaded with a force of 20 MPa in a special creep-measuring device for two hours, after which the test specimens were unloaded for two hours. The elastic deformation before the recovering phase is indicated by the creep, while the permanent deformation after the recovering phase is indicated by the permanent set.<sup>[1]</sup>

## Results of the measurements

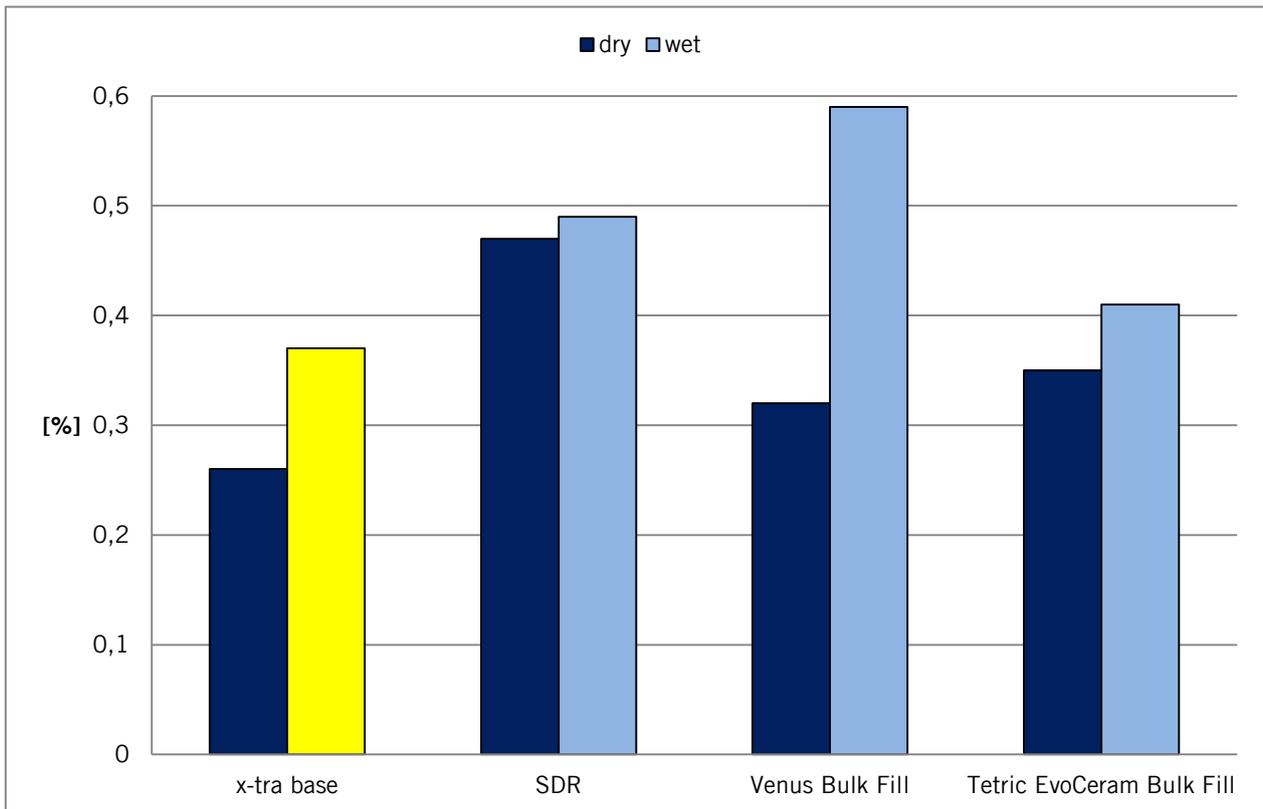
Overall, the creep and permanent set are slightly larger with flowable composites than with sculptable composites. Nevertheless, the flowable materials display very good properties, which ultimately confirm their indication as bulk fill materials. The results of the two measurements are shown in Figures 2 and 3.



**Figure 2:** Creep of the four bulk fill materials [%]

Figure 2 clearly shows that x-tra base has the lowest creep, at 0.8 % (dry conditions) to 1.0 % (wet conditions), compared to the competitor products. In contrast, the figures of 1.4 % to 1.8 % for SDR and Venus Bulk Fill show that these materials display significantly greater immediate deformation under load than x-tra base.

The permanent volume change after pressure loading (permanent set) of the four bulk fill materials tested is shown in Figure 3. This graph also indicates that x-tra base, at 0.25 % (dry conditions) to 0.35 % (wet conditions), is superior to the competitor products. SDR and Venus Bulk Fill display the largest volume change, with a permanent set of approximately 0.5 % to 0.6 %.



**Figure 3:** Permanent set of the four bulk fill materials [%]

**Conclusion:** x-tra base is characterised by low creep and high dimensional stability compared to other bulk fill materials. These properties are fundamental requirements for the long-term integrity of restorations and restoration margins. x-tra base acquires additional strength through the necessary occlusal covering with a layer of a universal composite, such as GrandioSO, for which excellent creep characteristics were likewise demonstrated in a study by Watts et al.<sup>[2]</sup>, and which therefore contributes to the long-term integrity of bulk restorations.

[1] El-Safty et al., *Dent Mat*, 28, 919-927, **2012**.

[2] Watts et al., University of Manchester, report for VOCO **2011**, data on file.