# SCIENTIFIC REPORT

## GrandTEC – Reinforcement of composites

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**Modern dental composites boast outstanding properties: exceptional handling, excellent aesthetics and permanent stability as a guarantee for the reliability of the restorations produced. Consequently, they are the key to success for almost all indications in the dental practice.**
**The only restrictions to be found are in applications following which the restoration is subjected to high tensile and shear forces. This is the case when distances are bridged, as when closing gaps in the replacement of missing teeth. Despite their great compressive strength, the composites are not capable of withstanding the masticatory loads in the mouth over larger distances on their own, meaning the material needs to be reinforced. Glass fibres are perfectly suited to this task, as their excellent tensile strength combined with the compressive strength of the composite brings about a synergistic effect which ensures outstanding stability even when bridging large distances. In their study, Caneppele *et al.* investigated precisely this synergy effect and compared the stabilities of composites subjected to different loads both with and without glass fibre reinforcement.**[1]

### Study design

This *in vitro* study used a steel mould containing the situation of a pontic with occlusal and approximal preparations. The distance to be bridged measured 7 mm; the prepared cavities had a minimum depth of 2 mm. Two composites were used: the packable composite GrandioSO (VOCO GmbH) and the flowable composite GrandioSO Heavy Flow (VOCO GmbH). The glass fibre reinforcements used were everStick C&B (StickTech Ltd.) and GrandTEC (VOCO GmbH). A total of 60 test specimens were created with the two materials GrandioSO (n = 30) and GrandioSO Heavy Flow (n = 30). Three different cases were tested for each group:

a) Composite **without reinforcement**
b) Composite with glass fibre reinforcement using **everStick C&B**
c) Composite with glass fibre reinforcement using **GrandTEC**

The two restorative materials used belong to the class of nanohybrid composites and differ in their viscosity. Whereas GrandioSO Heavy Flow is a flowable material, GrandioSO is a packable composite. The viscosity of a composite is predominantly the result of its inorganic filler content. This is 89 % for GrandioSO and 83 % for GrandioSO Heavy Flow. The filler content is also a measure of a composite's stability. Put simply: the higher the filler content of a material, the higher the stability. Using two different composites at the same time allowed Caneppele *et al.* to investigate the strengths of the two materials in comparison. The resilience of the complete restoration was measured in a three point flexural strength test with a driving rate of 1 mm / min and a force of 500 N.

## Results

Figure 1 shows a graphical representation of the results, with the corresponding values being given in Table 1.

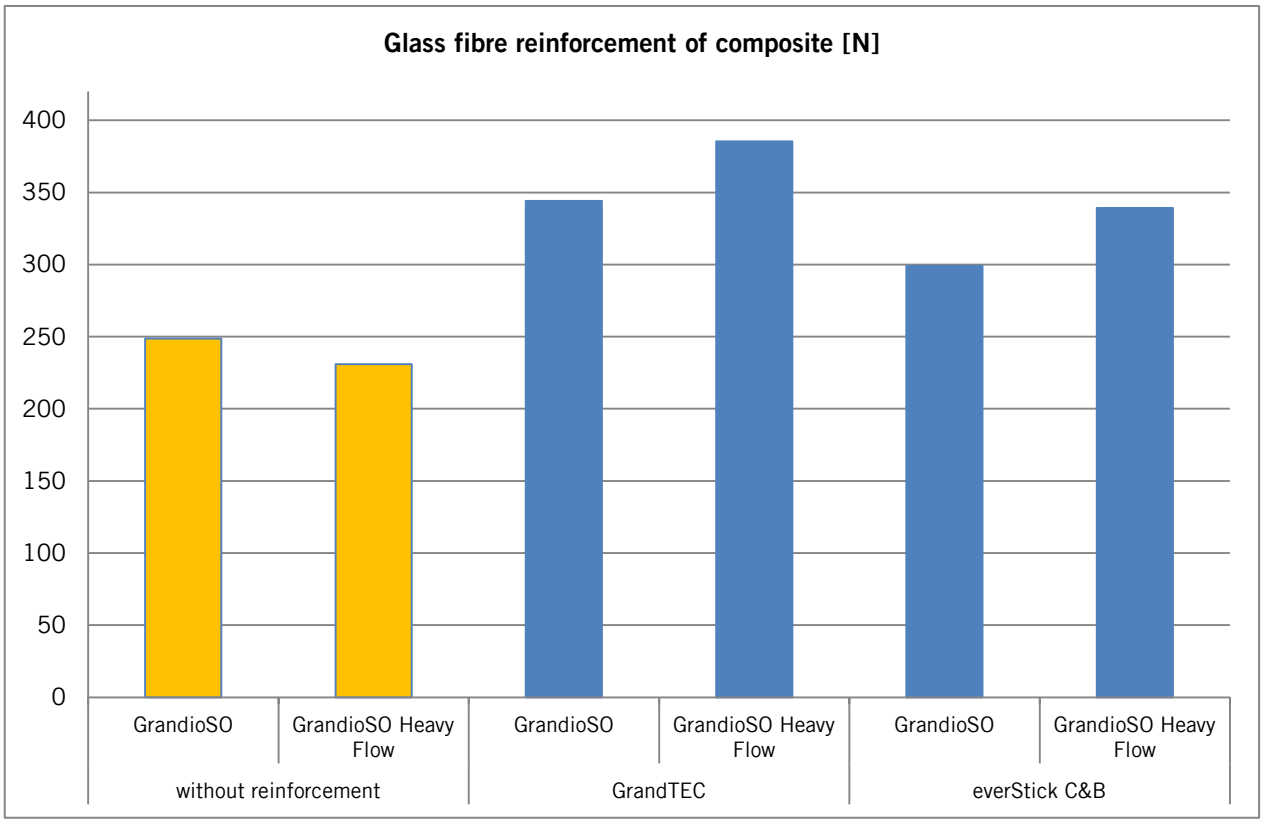


Figure 1: Graphical representation of the measured flexural strengths with and without glass fibre reinforcement

The two yellow bars in the bar chart show the values recorded for the strength of GrandioSO and GrandioSO Heavy Flow without glass fibre reinforcement. The strengths are clearly significantly lower compared with the reinforced restorations and amount to approx. 70 % (GrandioSO) and approx. 60 % (GrandioSO Heavy Flow) of the maximum values obtained in the test. In addition, the difference in the viscosities is also reflected in the first two values: due to the slightly lower filler content, the strength of the flowable GrandioSO Heavy Flow (approx. 230 N) is also slightly lower than that of the packable GrandioSO (approx. 250 N).
The strengths measured here are always to be viewed in relation to glass fibre reinforcement. Even if the diagram appears to show GrandioSO and GrandioSO Heavy Flow displaying strengths which are too low, both products – even without reinforcement – are outstanding materials with excellent physical properties. The best evidence for this is the range of indications for GrandioSO Heavy Flow: despite the flowability and the corresponding lower stability compared with the packable material, GrandioSO Heavy Flow is the only flow composite of its type indicated for class I to V restorations.

Table 1: Results of the investigation conducted by Caneppele *et al.* into reinforcement of composites with glass fibres

| **Composite** | **Modification** | **Flexural strength [N]** |
|---|---|---|
| **GrandioSO** | Without glass fibre reinforcement | 248.78 |
| | Reinforced with GrandTEC | 344.13 |
| | Reinforced with everStick C&B | 299.11 |
| **GrandioSO Heavy Flow** | Without glass fibre reinforcement | 231.03 |
| | Reinforced with GrandTEC | 385.34 |
| | Reinforced with everStick C&B | 339.33 |

The results achieved with the glass-fibre-reinforced composites make it possible to draw some very interesting and at the same time significant conclusions. In this case the materials behave the other way around: the low-viscosity material GrandioSO Heavy Flow achieves better results in combination with glass fibre reinforcements than the paste-like GrandioSO. This result can be

explained by the better wetting behaviour boasted by flowable composites. In connection with glass fibres in particular this property is of great significance, as complete wetting of the glass fibres is essential for the permanent stability of the restoration. Embedding of the glass fibres in the composite is the first step following adaptation of the fibres in the oral cavity. There is always a risk of hydrolysis (chemical breakdown due to water/moisture) if glass fibres are exposed as a result of incomplete wetting. In such cases, the restoration would display potential points of attack for quality defects in terms of the colour stability, the bond to the dental hard tissue and thus the durability of the treatment. For this reason, all manufacturers of glass fibre reinforcements, including VOCO, specify in the respective instructions for use that **the first embedding layer of composite following adaptation of the fibres in the oral cavity must be produced from a flowable composite.** Depending on the clinical situation, a packable composite is also recommended in addition to the flow composite for further modelling of the restoration. This aspect is evident in both the case of reinforcement with GrandTEC and the case of reinforcement with everStick in this study: the flowable material GrandioSO Heavy Flow achieves better results in both cases.

The fact that the GrandTEC glass fibre reinforcements in this study did slightly better than the everStick reinforcements may be due to the fact that the everStick reinforcements have a slightly lower diameter (1.5 mm) than the GrandTEC glass fibre reinforcements. As such, there is less material available to the composite overall for the reinforcement.

**Conclusion: Glass fibres combined with composite produce a synergy effect with regards to the stability of a restoration. The high tensile strength of the fibres as an additive for the excellent strength of modern composites opens up completely new application possibilities. This enables the dentist to handle special cases such as the bridging of large distances quickly and without any complications, with the result that glass fibres are widely employed not only in prosthodontics, but also in traumatology and orthodontics. The initial embedding of the fibres following adaptation in the oral cavity with a flowable composite is highly important. Overall, glass fibre reinforcement represents a genuine alternative which translates to significant time and cost savings for both the dentist and the patient.**

[1] Caneppele TMF, Silva IO, Borges AB, Borges ALS, Torres CRG, Influence of glass fiber reinforcement and resin viscosity on the resistance to fracture of adhesive partial fixed prostheses, *Braz Dent Sci*, 16, 1, **2013**.