

# SCIENTIFIC REPORT

## Grandio Flow – Rheology

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**With the nano-hybrid composite Grandio Flow, VOCO provides a flowable that has incredibly low viscosity with a filler content of 80.2 % and is thus an ideal restorative for initial lesions within the scope of minimally invasive dentistry.**

Modern flowables must satisfy many requirements in practice. In addition to abrasion resistance and minimal polymerisation shrinkage, simple handling during application also belongs to the list of requirements. The property that plays the largest roll in this context is the flow behaviour of the flowable. This must be liquid on the one hand to easily flow into small cavities, and stable on the other hand, so that it does not flow away when restoring maxillary teeth, for instance. Since these two requirements are rather contradictory, a good material must permit its viscosity to be controlled (flow on demand).

### Filler content

The filler content of a composite greatly affects the flow behaviour, whereby the flow behaviour generally worsens with increasing filler content. In order to achieve good flow behaviour, the filler contents in flowables are thus up to 20 % less than what is found in corresponding hybrid materials. The filler content is indeed an important parameter that has a powerful impact on the properties of the material concerning stability, abrasion resistance, polymerisation shrinkage and other aspects. Therefore a compromise must normally be reached between high filler content and good flow behaviour. Through the integration of nanotechnology, VOCO can offer a flowable with a filler content of 80.2 % that has excellent flow behaviour. This is considerably higher than comparable products and even higher than many "normal" composites.

### Rheological properties of flowable hybrid composites

How the flow properties of several flowables behave under different amounts of movement was analysed in a study at the University of Louvain (Brussels).<sup>[1]</sup> Flowable composites belong to the thixotropic materials. They are thus compounds that decrease in viscosity when movement is supplied and, through this property, allow "flow on demand" to be achieved.

To determine viscosity, the tested composites were exposed to different amounts of movement, which increase from left to right on the x-axis (indicated as frequency of revolutions of the discs) in the following diagram. Small numerical values on the y-axis represent low viscosity, where larger ones represent high viscosity. First of all, it can be stated that all tested flowables offer sufficient stability under static conditions and occurring differences have no clinical relevance here.

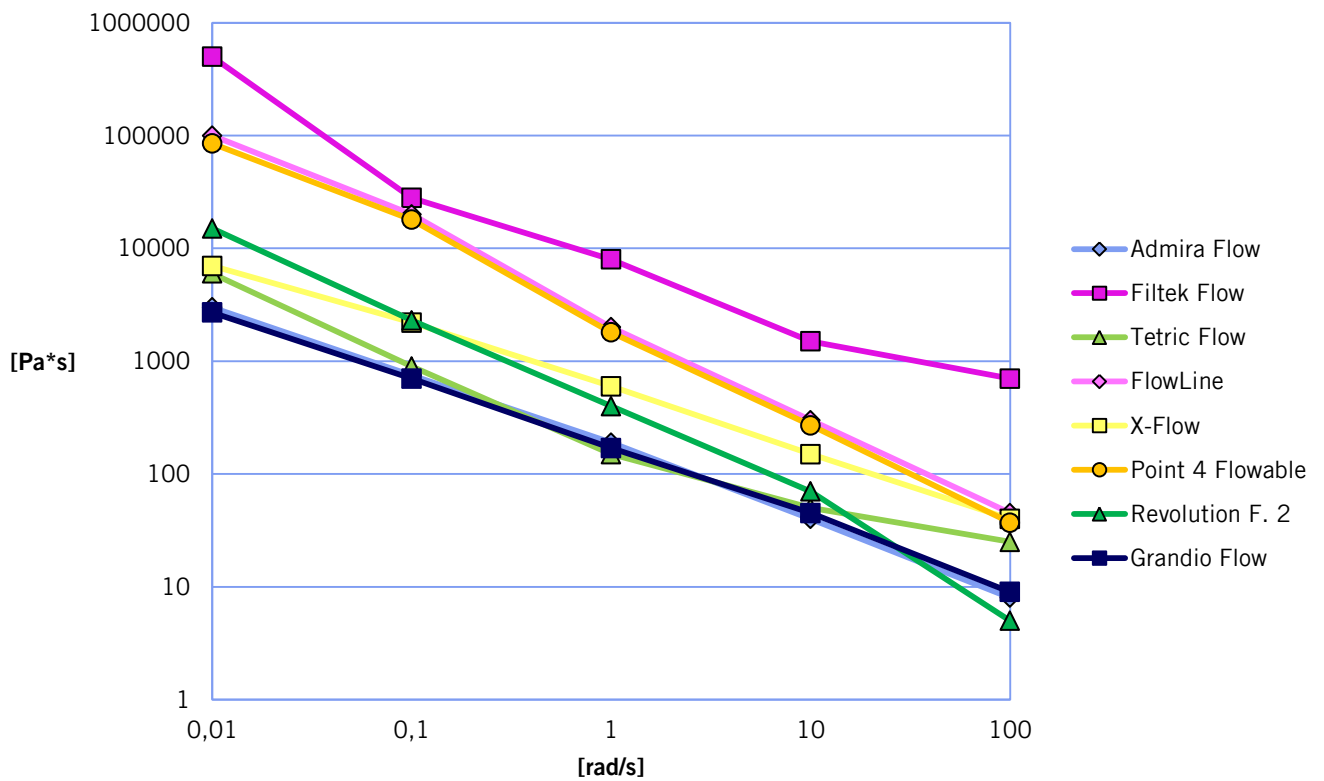


Figure 1: Viscosity (in Pa\*s) depending on the Shearing frequency (in rad/s) <sup>[1]</sup>

The change in behaviour with movement is interesting. Grandio Flow scored in the top group in all frequency ranges; therefore its ability to change to a liquid under movement is outstanding. Tetric Flow is slightly more liquid in the medium frequency range. Admira Flow and Revolution Formula 2 offer the best values in the high frequency range. It must be taken into consideration, however, that the good flow behaviour of Tetric Flow and Revolution Formula 2 was bought here with a significantly lower filler content: Tetric Flow (syringe) - 63.8 %, Revolution Formula 2 - 60.0 %.<sup>[2]</sup> The good viscosity values here are connected to compromised restorative properties. The high filler content found in Grandio Flow is obviously not achieved at the expense of the flow properties, which underlines the significance of nanotechnology in modern composites.

**Conclusion: Grandio Flow is a flowable, nano-hybrid composite that belongs to the flowables with the best flow properties in the active state out of all the tested hybrid composites. This outstanding flow behaviour is not achieved at the expense of the filler content however, since Grandio Flow offers the mechanical properties of a micro-hybrid composite with a filler content of over 80 %.**

[1] S. Beun, C. Bailly, J. Devaux, G. Leloup, *Dental Mater.* **2008**, 540-555.

[2] Statements from Manufacturer.