SCIENTIFIC INFORMATION

Grandio - Heating before application

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Whether warming a composite before its application is advantageous has been discussed in the literature for quite some time. The following is a summary of this topic in the technical literature. Both the possible advantages in plasticity and potential improvement of the physical properties in polymerised composite are discussed here.

Plasticity analysis

The physical properties of composites depend on the filler content to a large degree. The rule of thumb for this can be established as being the higher the percentage of filler in the composite, the better the properties of the material. Since the filler content, however, affects the viscosity of the composite, there is a limit of about 80% filler content. A higher filler content leads to a material that is too hard, difficult to handle and exhibits poor adaption to the cavity margin, which is even more important from a medical viewpoint. Warming the composite before application is sometimes recommended to avoid this problem, since the heating leads to a reduction in the viscosity.[1]

Grandio, the nano-hybrid composite, has a filler content of 87%. This is possible, since nano-fillers are used in this material. One of the special properties of nano-scaled filler particles is that they behave like liquids and thus do not contribute to the solidification of the material. Grandio thus also has excellent handling at room temperature and heating it to improve the adaption to the cavity margin is not necessary. An additional interesting property of nano-particles is its effect on the thixotropic behaviour. Thixotropy means that a material becomes more liquid under movement. Grandio can be liquefied with gentle movement; an optimal adaption by the movement in the positioning of the individual layers during the restoration is possible as a result.

In summary, it can be said about the plasticity that warming some composites before application is advantageous. Grandio, the nano-hybrid composite, however, already has outstanding flow behaviour at room temperature. Heating Grandio does not lead to an impairment of its properties, but it does not result in any advantages in the application.

Testing the physical properties

In addition to the effect on the viscosity of the material, it is of course necessary to examine the additional effects on the physical properties of a composite. Chemical reactions almost always depend on the temperature. This is also the case with radical polymerisation. Heating can lead to an extended visco-elastic phase and it affects the setting through the modification of the mobility of the monomers. An increase in temperature also leads to an acceleration of the reaction.

Rueggeberg et al. have demonstrated in numerous studies that the rate of conversion can be increased during light-curing by heating the material beforehand. [2] However, they only examined a time period of up to 300 s after the light-curing. The

polymerisation reaction does not stop directly after the light-curing; rather, the reaction continues to take place for hours. In most cases, the physical parameters are first recorded 24 hours after the composite has been light-cured for this reason. A current study at the University of Erlangen (Germany) came to the conclusion that the total conversion is equal to the examination of a longer period of time. [3] Heating thus does effectuate acceleration, but does not affect the end result of polymerisation. Other studies generally question the suitability of conversion rates for the evaluation of the stability of a material. [4] The effect of warming composites after application was also examined in additional studies; [5] it must be questioned here, however, to what extent a study on heating up to 125° C after curing is clinically relevant.

The physical properties of Grandio after heating the material before application were examined in a study at Gazi University (Turkey) (Figure 1).[6]

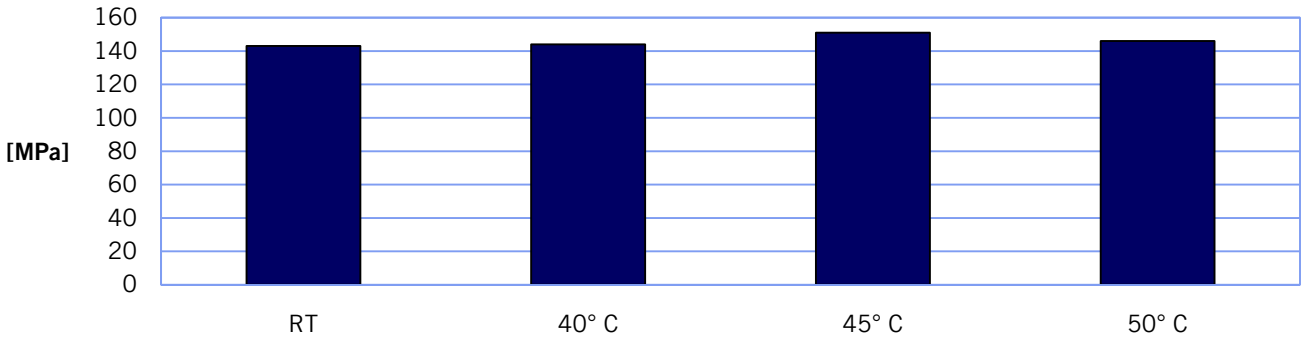

Figure 1: 3-point transverse strength [MPa] of Grandio depending on the initial temperature of the material

The transverse strengths at different temperatures do not cause significant differences in the transverse strength. Arisu et al. determined the E modulus in an additional investigation. It was also shown here that heating Grandio did not have a significant effect on the physical parameters of the material.

An improvement in the physical properties through warming could be proven in some studies with the use of other composites: Here, temperatures of 70/100/140°C [7], 54.4°C[8] or 60°C[9] were recorded in the analysis. These results, however, obviously cannot be transferred to Grandio and thus appear to be closely connected to the composition of the materials.

Investigations by Dr. Elhejazi from the King Saud University in Ryadh (Saudi Arabia) [10] show that increasing the temperature of the composite can even have a negative effect on the shrinkage:

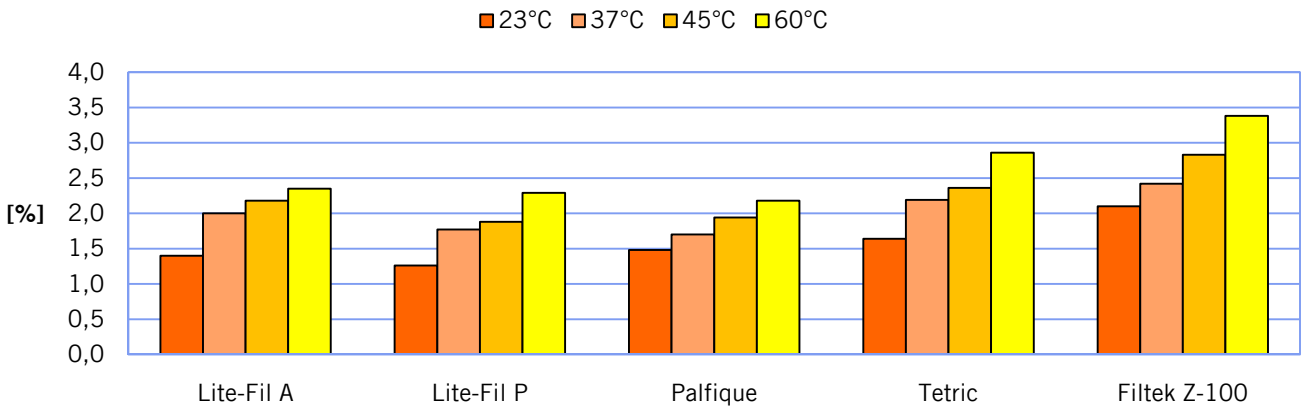

Figure 2: Effect of the temperature of the composite on shrinkage [%]

In addition to increased shrinkage, heating composites before the application holds another risk: Overheating the pulp. Overall temperature increases of more than 5.6° C are deemed critical, or differently calculated, an increase in pulp temperature over 41° C. Since chemical reactions always produce heat, the temperature of the pulp is increased alone by the polymerisation. A study by the Medical College of Georgia examined the additional heating of the pulp chamber from the use of pre-warmed composite using a model. [11] Daronch et al. could prove a pulp temperature of 39.4° C with a standard deviation of 0.4° C after the end of polymerisation with a composite warmed to 54° C in their experimental setup. This value is about 1 degree over the temperature that was determined for the composite at room temperature; both lie below the critical value. The study also said, however, that the actual temperature of the material amounted to only 36° C when the composite was heated to 60° C with a Calset™ unit. If a higher temperature is reached through longer periods of heating, critical temperature increases can possibly develop.

An additional aspect is the choice of the light source. Daronch et al. used a halogen lamp; this type of lamp is known to lead to higher temperatures than a LED lamp. The study thus attempted to already represent a type of worst case scenario. Even higher temperatures can, however, be reached by using plasma lamps [12] - Using plasma lamps when working with pre-warmed composites thus entails a special risk.

Conclusion: Heating composites before application is advantageous for the handling of some composites. A positive effect on the physical properties could in fact be proven for some composites, but not for the nano-hybrid composite Grandio. Grandio already exhibited ideal properties at room termperature. Heating before application is absolutely unnecessary.

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