Polymerization Shrinkage Stress and Flexural Strength of Nano-Composites

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Introduction:

Nano-composites are the new generation of composite materials and show beside nice handling features very good physical properties. One of the most promoted feature of nano-composites is reduced polymerization shrinkage, but which is mainly presented as result of volumetric shrinkage in %. However, polymerization shrinkage force, which is measured in MPa and is the result of the product of shrinkage and E Modulus, is clinically more relvant as it effects the bonded interface to the tooth structure.

Objectives:

Nano-composite resins claim to have low polymerization shrinkage and high physical properties which are important for the longevity of composite restorations. The purpose of this study was to determine and compare the polymerization shrinkage stress and flexural strength of different nano-composites.

Methods:

The composites tested were: Tetric EvoCeram (TEC) (Ivoclar Vivadent), Filtek Supreme XT (FS) (3M Espe), Quixfil (QX) (Dentsply), Grandio (GR) (Voco) and NEUN (NE) (Heraeus Kulzer).
After 24h, flexural strength was measured with 10 specimens (25x2x2mm) per group in a universal testing machine (Zwick Z1445) with a crosshead-speed of 0.75 mm/min (standard EN ISO 4049:2000).
To determine polymerization shrinkage stress, cylindrical cavities (∅ 4mm) were prepared in Araldit B epoxy resin plates (40x40x4mm) and pretreated with the Rocatec system (3M Espe) to ensure bonding of the resin composites. The resin composite specimens (n=10) were exposed to light for 60s with a QTH curing device (Translux Energy, Heraeus Kulzer). The samples were stored dark and dry (23°C) during the first hour and after that in distilled water (37°C). Polymerization shrinkage stress data (MPa) 1h and 24h post exposure were calculated based on the diameter of the isochromatic curves of first order, obtained from the Araldit plates. Statistical analysis was carried out with the Wilcoxon test (p=0.05, Bonferroni adjustment).

Figure 1: Zwick Universal Testing Machine

Figures 2 a/b/c: Movement of the gloved test tube towards the freshly-mixed impression material.

Results:

After 24h the following mean values in MPA were recorded:

➢Polymerization shrinkage stress [MPa]:
Tetric Evo Ceram: 3.6[a], NEUN: 4.0[b] , Filtek Supreme: 4.2[c] , Quixfil: 5.0[d] ,Grandio: 5.7[e] .
Letters indicate statistical significance.

➢Flexural strength [MPa]:
Tetric Evo Ceram: 105, NEUN: 155, Filtek Supreme: 111 , Quixfil:130 ,Grandio: 136.

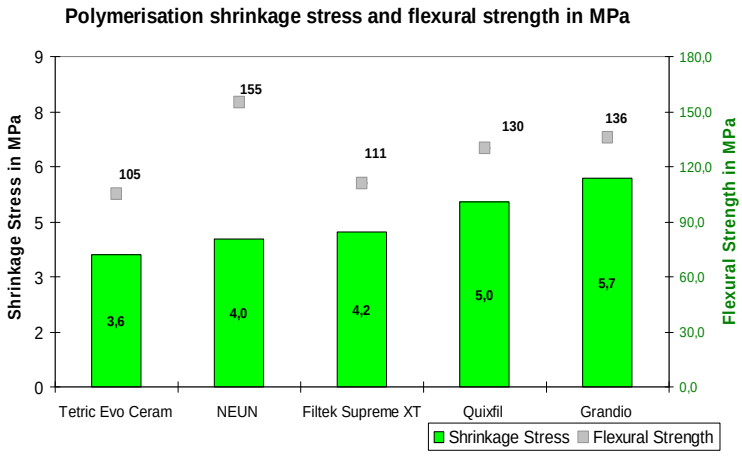

Figure 1: Results for polymerization shrinkage stress and flexural strength of the tested composites.

Conclusions:

There were significant differences in polymerization shrinkage stress after 24h between all nano-composites tested whereas Tetric Evo Ceram and NEUN produced the best results. NEUN presented the highest flexural strength. The combination of low shrinkage values and high flexural strength for NEUN may be promising for good clinical performance, which has to be verified in clinical studies.

References:

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