

Shrinkage Stress in Photoactivated Composite Resins: Significance of Product Type

C.Charton^{1,2}, C.Amory¹, P.Colon³ & F.Pla²

1. Department of operative dentistry and endodontics, Faculty of dentistry, Nancy. 2. Chemical Engineering Sciences Laboratory - UPR 6811 - INPL - ENSIC of Nancy. 3. Department of operative dentistry and endodontics, Faculty of dentistry, Paris 7.

INTRODUCTION: The interfacial integrity of composite resins depends on many factors and, above all, the polymerization shrinkage stress related to the dimethylacrylate based matrix of these products. The purpose of this work was to investigate the influence of composite type on the polymerization shrinkage stress. In particular, the hypothesis that the less rigid materials would develop lower contraction stresses than rigid materials was verified.

METHODS: Five composite resins, two packable (Solitaire, Solitaire 2), two micro-hybrid (Aelitefil, Z100) and one hybrid (Clearfil AP-X), were tested in this study. *Shrinkage stress:* a mechanical testing machine recorded the polymerization contraction stress (MPa) of cylindrical composite specimens ($\varnothing = 6$ mm; $h = 2$ mm; C -factor = 1.5; $n = 5$) over a period of 400 s. The samples were polymerized over a period of 60s using the standard high power density curing mode (800 mW/cm²) of the Elipar Trilight* (3M-ESPE) light curing unit. *Filler load:* a thermogravimetric analysis beam balance measured the mineral mass (wt%) of a 0.1g ($\pm 10^{-3}$ g) sample, after a heating phase in a controlled gaseous flow and atmosphere: increase in temperature from 20 to 750°C (rate: 40°C.min⁻¹), plateau at 750°C for 10 min then free cooling descent.

RESULTS: 1. *Shrinkage stress:* The mean values and standard deviations of the maximum shrinkage stress (MSS) after 400 s are listed in Table 1.

Table 1. Shrinkage stress and filler load of the materials tested.

Material	Maximum Shrinkage Stress (MPa _{400s})	Filler load (wt%)
Aelitefil	1.45 (0.06)	74.2 (0.03)
AP-X	0.92 (0.05)	83.1 (0.07)
Solitaire	1.51 (0.07)	66.2 (0.21)
Solitaire2	1.29 (0.08)	70.9 (0.27)
Z100	1.04 (0.03)	79.3 (0.18)

This data was taken from the stress/time curves (Fig. 1). There was a short time lag between the beginning of light curing and the first stress recorded, so all curves were S-shaped. Solitaire showed a distinct delay before the stresses were recorded. The Student t-test (independent samples) modified by Bonferroni revealed that Solitaire and Aelitefil had a

significantly greater MSS (no statistically significant difference between them) than any of the other materials. Clearfil AP-X had the lowest MSS without a significant difference compared to Z100. Solitaire MSS was 164% of the Clearfil AP-X value.

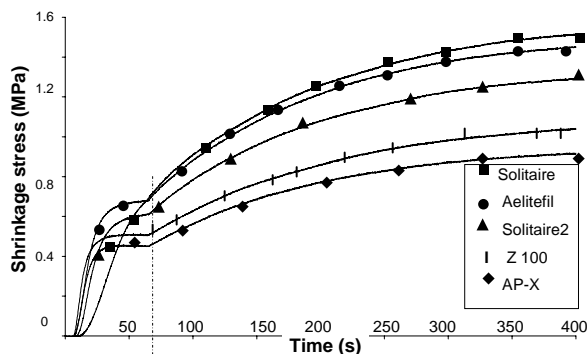


Fig.1: Graphs showing shrinkage stress vs.time for the materials tested (dotted line shows the end of irradiation).

2. *Filler load:* The mean values and standard deviations of the filler load (wt%) are listed in Table 1. The Student t-test (independent samples) modified by Bonferroni showed that there is a significant difference among all the products. The simple Pearson correlation calculation established a negative correlation between the shrinkage stresses and the filler load of the composites.

DISCUSSION & CONCLUSIONS: Our results show that a highly loaded composite having lower polymerization shrinkage and higher elastic modulus (rigidity) leads to lower contraction stress. It would seem logical that a high load tends to reduce shrinkage stress because it implies a reduction in the quantity of matrix responsible for the contraction phenomenon¹. The study by Watts et al.² confirmed that assertion with an experimental composite. On the other hand, studies carried out on commercial composites found a strong positive correlation between filler level and contraction stress³ which would indicate a strong influence of the resin matrix composition and notably its DC⁴, in determining the development of the contraction stress behaviour of the composites.

REFERENCES: ¹M. Iga et al (1991) *Dent Mater* **10**:38-45. ²D.C. Watts et al (2002) *J Dent Res* **81**:A308, IADR Abstr. n°2444. ³J.D. Pearson et al (2001) *Gen Dent nov-dec*:643-7. ⁴R.R. Braga and J.L. Ferracane (2002) *J Dent Res* **81**:114-8.