Program # 208

Rheology of Dental Restorative Cement that Includes Silica Nanoparticles

N. Zaltsman, A. Valdman, B. Zalsman, K. Lizenboim, A. Khaskin, A. Suvorov and I. Suvorov

BJM Laboratories Ltd., Or-Yehuda, Israel

BJM LAB
B.J.M. Laboratories Ltd.

INTRODUCTION

Rheological properties of dental restorative cements are playing significant role in their ease of use as keeping the desired form while curing, flowing out from the auto mixing syringe and mixing.

Fumed Silica Oxide nano particles are playing role as rheological regulators, since they can affect selectively on some of the parameters as Yield Stress and Flow Index.

When the right Silica Oxide filler is used for certain purpose, it cat lead to it's lower concentrations that allows insertion of other filler particles as heavy glass powders that are crucial for materials mechanical properties.

N (viscosity) = T/γ

T = shear stress = $T^{\circ}+K\gamma^{n}$

T° (or σ°) is the minimal stress at which the yield occurs.

K – consistency

n is the index of "behavior" of the material.

For n<1 : Pseudo Plastic

n=1 : Newtonian

OBJECTIVES

The purpose of this study is to investigate and characterize the rheological behavior of 60/40 Bis-GMA/TEGDMA blend frequently used in dental materials in presence of the different fumed silica (FS) particles, 6μ-silanized glass powder (GP).

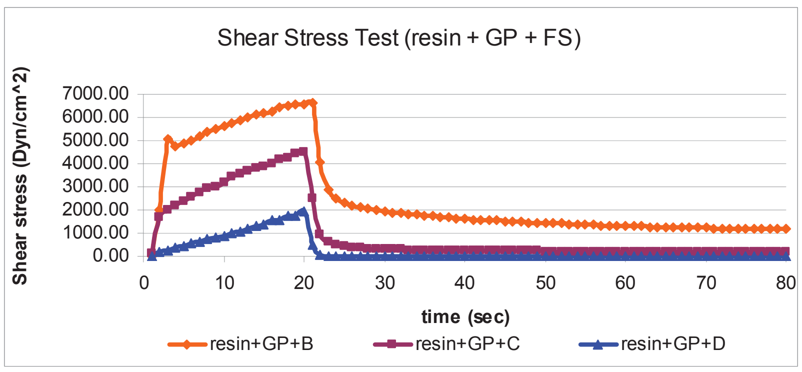
METHODS

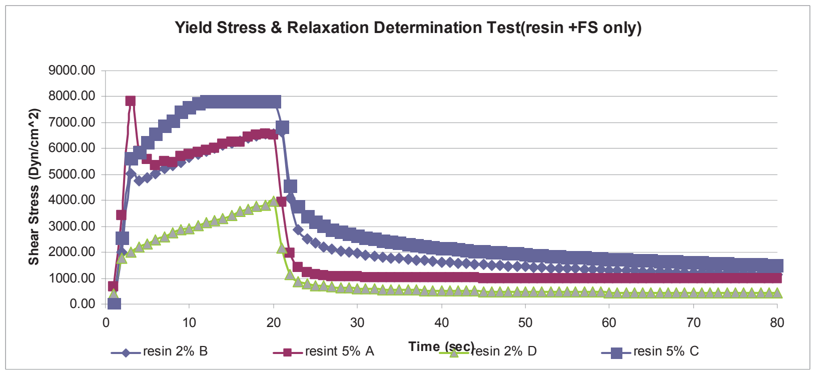
Four different commercially available treated FS particles were tested for their rheological nature within the resin blend: A – (0.2-0.3μ) untreated FS, B - (0.2-0.3μ) FS treated with polysiloxane, C - (0.2-0.3μ) FS with siloxane and D – (0.2-0.5μ) methacrylsilane FS. Viscosity measurements were taken by Brookfield viscometer in two different tests.

At first test all of the solids were examined for their rheological nature within the resin blend by measuring viscosity at varying shear rates and comparing within themselves. The second test consists of three continuous stages: determining the yield stress, accelerating the shearing, stopping the shearing but continuing to measure the stress that still occurs. This comparison is to simulate the recovery of materials when no shear forces appear after flowing at high stress. At this stage the example consists of 40% (by weight) resin blend, 55% (by weight) 6μ glass powder and 5% (by weight) of particular FS for each sample.

RESULTS

FS	Flow Index (2%)	Flow Index (5%)	Yield Stress (5%) (Dyn/cm^2)	Torque Relaxation (5%)
Untreated FS	1.0	0.30	100	0
Polysiloxane Treated FS	0.8	0.61	2500	21
Siloxane Treated FS	0.8	0.50	1700	16
Methyl Methacrylate Treated FS	1.0	0.30	100	0





DISCUSSION

- The Yield Stress value is varying as a function of the surface treatment agent nature of FS. More compatible (methyl methacrylate) treated particles induce less internal friction and as a result lower YS. Using of siloxane chains could be more effective for prevent "flowing" of the material.
- Longer siloxane chains improve the YS and reduce the relaxation level at the end of shearing.
- Surface treatment agents have significant role in pseudoplastic nature of FS. Thus, as longer siloxane chains are, the lower FS concentration is needed to reduce the Flow Index.
- Longer surface chains on FS allow using of lower nanofiller and higher GP concentrations, desirable for mechanical properties in dental restorative cements.

CONCLUSIONS

- Surface treatment agents on FS nanoparticles provides opportunity to increase only the desired rheological parameters. As it can be seen the longer siloxane chains increase the Yield Stress and reduce the relaxation level.
- Methyl methacrylate surface treated FS is more compatible with the resin part and induces a lower Yield Stress and more pseudoplastic character (lower Flow Index).

FUTURE WORK AND RECOMENDATIONS

- We will examine the mechanical and thermal properties changes of the materials that include treated FS. The aim is to investigate the chemical and mechanical interactions of treated FS's as a function of surface agents