# Toothbrush Surface Gloss vs. Filler Particle Size of Composites

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## INTRODUCTION

Loss of surface gloss after toothbrushing has been suggested as a mechanism for loss of clinical luster in restorations (AADR abst. #535 2001; IADR absts. #2690 2002, #590 2004 ). The data suggested that the surface gloss of the composites was related to the filler particle size of the composites. In this study, the Equilibrium Gloss (EG) of various composite resins was measured after long-term toothbrushing and compared to the filler particle size. EG was plotted vs. Filler Particle Size and a mathematical relationship was found between the two variables. The data suggest that surface gloss in composite restorations is related to filler particle size. If the filler particle size is at or below the wavelength of visible light, the particles behave as if they are in a solution and interact minimally to incident light at the restorative surface. When this happens, the clinical luster remains high.

## OBJECTIVE

The purpose of this study is to measure the surface luster of commercially available composite resins after toothbrushing. The surface gloss was tabulated according to filler categories.

## MATERIALS

| | |
|---|---|
| Sinfony Enamel (S) | Lot 009 |
| Herculite Ultra Enamel (HU) | Lot 3097991 |
| Herculite XRV Enamel (HXRV) | Lot 2954856 |
| Esthet-X (EX) | Lot 80911 |
| Filtek Supreme Enamel (FSE) | Lot 8ER |
| TPH 3 (T3) | Lot 806232 |
| PI Premise Indirect A3 (PI) | Lot 3142141 |
| Heliomolar (H) | Lot 919965 |
| Filter Supreme Translucent (FST) | Lot 2TE |
| Exp Composite (PIX) | Lot 528VB109 |

## METHOD

The toothbrush test method and gloss measurements were previously described[1]. The Equilibrium Gloss (EG) of five samples of each material was measured. A composite of large particle size was also compounded and cured in the same manner as Premise Indirect™. The filler particles were isolated by burn-off @ 650 ºC or by solvent extraction of the paste. Particle size was measured by laser particle size analysis (LA 921, Horiba Corp.) after ultrasonic dispersion in 0.01%TSP sol'n, 15 min.; or by SEM analysis of the primary particles. The means and s.d. were calculated and anova analysis ($p<0.05$) of the data was performed to determine significant differences between the means. The EG of the composites was plotted vs. filler particle size and points connected by an Excel polynomial trendline.

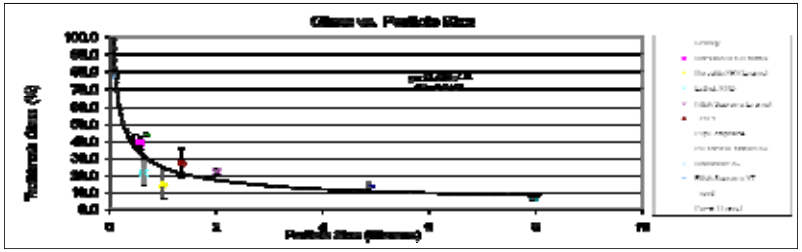
## RESULTS

The data are reported in the attached table. EG values with superscripts a-d generally have high surface gloss, whereas values @ e-i have a matte or dull surface gloss. In terms of % gloss, values above 60% give excellent, 40% give good, 20% give a matte and below 15% give a dull surface gloss.

Toothbrush Gloss and Particle Size of Composites

| Material: | S | HU | HXRV | EX | FSE | T3 | PI | H | FST | PIX |
|---|---|---|---|---|---|---|---|---|---|---|
| EG (%, s.d.) | 43.8, 0.8$^{b}$ | 39.0, 4.0$^{b,c,d}$ | 15.0, 8.6$^{e,f,g,h}$ | 21.3, 7.1$^{e,f,g}$ | 22.0, 1.8$^{e,f}$ | 27.0, 8.6$^{c,d,e}$ | 13.8, 2.3$^{e,f,g,h,i}$ | 40.5, 3.8$^{b,c}$ | 77.1, 0.8$^{a}$ | 5.8, 0.91$^{e,h,i}$ |
| Filler Particle Size (μ, s.d.) | 0.66, 0.30 | 0.57, 0.89 | 0.99, 0.59 | 0.64, 2.65 | 2.01, 1.45 | 1.34, 1.10 | 4.87, 4.51 | 0.45, 3.04 | 0.09, 0.01 | 7.95, 6.06 |

values with the same superscript letters are not significantly different



## DISCUSSION

The attached figure shows a plot of EG of ten composites vs. filler particle size. The polynomial trendline is of the form:

$$EG = a X^{-b},$$

where **EG = Equilibrium Gloss** (%), **X = Filler Particle Size** (μ) and **a,b are constants** ( $r^2 = 0.82$).

In general, as X becomes larger, the EG drops exponentially to a low value below 10%. If X is below the wavelength of visible light, the fillers behave as if they are in solution and interact minimally with light at the restorative surface. When this happens, the EG remains high. On the other hand, as the filler particle size increases beyond the wavelength of visible light, the EG drops exponentially. This is because the particles exposed at the surface begin to randomly disperse the incident light, resulting in a dull surface.

The EG of composites seems independent of filler classification (see accompanying paper), but is related more to the ultimate size of the filler particles at the restorative surface. If the filler particles are larger or contain aggregate clusters larger than the wavelength of visible light, they randomly disperse incident light resulting in a dull surface. Regardless if the material contains nanoparticles, if it also contains large particles or aggregate nanoparticles of size larger than the wavelength of visible light, it will result in a dull surface.

## CONCLUSION

The EG of composites after toothbrushing was correlated to filler particle size. The data suggests that toothbrushing may be a source of clinical loss of luster in composite restorations.

## REFERENCES

1. J. Cruz, V. Bui, A. Kobashigawa and E. Shellard: "Surface Luster of Indirect Composite Resins after Toothbrush Wear."; Abst. # 2690, J. Dent. Res. V. 81, Special Issue A, March 2002.