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# Surface Roughness of one Nanofill and one Silorane Composite after Polishing

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**A B S T R A C T**

*The aim of this study was to compare the roughness of the surface of one nanofill (Filtek Supreme XT, 3M Espe, St. Paul, USA) and one silorane (Filtek Silorane, 3M Espe, St. Paul, USA) composite after polishing. Five specimens of each composite were polymerized under a polyester strip for 40 seconds. After curing four probes were polished with different Sof-Lex discs and one probe with Pogo for ten seconds. For the surface appointment a contact stylus profilometer was used. The profilometer made ten tracings for each sample at different locations. There was a significant difference in roughness between both composites. The Ra (average surface roughness) results for the silorane composite were almost always significantly higher than for the nanofill composite (T-test). For both composites Sof-Lex fine and superfine discs produced smoother final surfaces than Pogo. The nanofill composite used showed the smoothest surfaces after the polishing and finishing procedures.*

***Key words:*** *nanofill composite, silorane composite, surface roughness, profilometer, polishing*

## Introduction

Nanotechnology has already influenced dentistry by inventing new composites based on nanofillers and nanoclusters. A nanofill composite may offer the polish retention of micro-filler composite and mechanical properties of a hybrid composite. Earlier studies showed that nanofill composites lead to higher surface quality and better polish maintenance[1–4].

A new composite restorative material has been introduced to the dental market with a silorane based matrix, different to conventional composites that have a Bis-GMA based matrix. According to manufacturer's claims it has a comparatively low shrinkage and a very low water sorption, due to the hydrophobicity of the silorane matrix. Composite surfaces have to be polished to reduce the risk of gingival irritations, surface staining, patient discomfort and the formation of secondary caries[5–7]. Surface roughness is defined as the finer irregularities of a final restoration which are a result of the configuration and manufacture of the material.

The surface finish depends on the size, shape and quantity of the composite filler particles. Therefore, a wide variety of finishing and polishing tools are available.

The effect of polishing systems on surface roughness has been reported to be material and product dependent[8].

Due to the development of nano- and silorane composites, scientific studies are necessary.

The purpose of this survey was to investigate the surface roughness depending on the composite and polishing system used.

## Materials and Methods

For this study two commercially available resin composites, one based on nanofiller technology (Filtek Supreme XT, 3M Espe, St. Paul, USA) and one based on siloranes (Filtek Silorane, 3M Espe, St. Paul, USA) have been used (Table 1).

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**TABLE 1**
COMPOSITE PROPERTIES AND MANUFACTURES

| Material | Manu facturer | Filler | Matrix | Average filler size | % by Vol. |
|---|---|---|---|---|---|
| Filtek Supreme XT | 3 M Espe St. Paul, USA | Nanofiller2r$O_2$/$SiO_2$ and Nano cluster | BIS-GMA, UDM-, TEGDMA- and Bis-EMA-resins | 0.6–1.4 μm | 59.5 (78.5% by wt) |
| Filtek Silorane | 3 M Espe St. Paul, USA | Quarz and Yttrium fluoride | Siloranes | 0.1–2.0 μm | 55 (76% by wt) |

For polishing, four aluminium oxide-impregnated discs different in their surface roughness (Sof-Lex, 3M Espe, St. Paul, USA) and a one step diamond micro polisher (Pogo, Dentsply Caulk, Milford, USA) were used (Table 2). The Sof-Lex discs have been utilized, because aluminium oxide discs have been proposed as standard protocol[9].

Five specimens of each composite were fabricated in a metal mold. The cavity design was disc shaped (6 mm diameter x 3 mm deep) and the materials were light-polymerized (Polylux, Sirona Dental, Bensheim, Germany) under a polyester strip for 40 seconds. The polymerization unit was controlled with the help of a curing radiometer (Optilux Radiometer, Kerr, Middleton, USA) to ensure constant light output intensity (400 mW/cm$^2$). The polyester strip was used to prevent an oxygen inhibited layer and to create an even surface a glass-plate was used. The distance between composite surface and the tip of the lamp was 0.8 mm.

After curing, each composite probe was polished for 10 seconds by taking a low speed fissure bur (green, 3000 rev/min); a new polishing product was used for each sample and was cast away after use.

A single operator performed the polishing procedure. The operator tried to use constant pressure to prevent heat build-up and the possibility of making drills. Following the finishing procedures the specimens were water rinsed with air water spray to remove any surface debris and then air dried for 10 seconds.

**TABLE 2**
PRODUCTS AND MANUFACTURERS OF THE POLISHING SYSTEMS

| Polishing systems | Composition | Manufacturers |
|---|---|---|
| Pogo™ / Enhance | Diamond coated micro-polisher | Dentsply/ CaulkMilford, USA |
| Sof-Lex™ | | 3M Espe |
| | Aluminium oxide | St. Paul |
| | | USA |
| Sof-Lex black (coarse) | 100 μm | |
| Sof-Lex dark blue (medium) | 40 μm | |
| Sof-Lex light blue (fine) | 24 μm | |
| Sof-Lex turquoise (superfine) | 8 μm | |

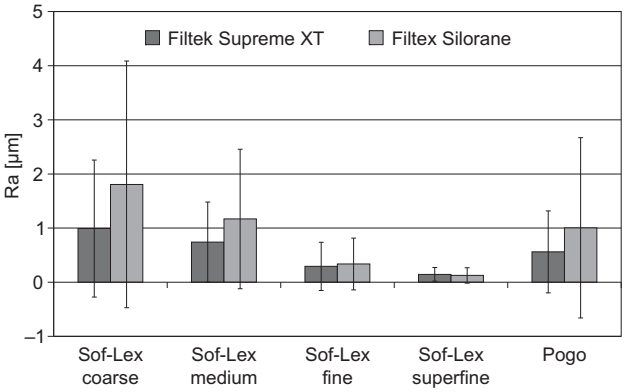


*Fig. 1. Significant difference in roughness between both composites.*

After polishing all composite specimens were examined and photographed under a reflected light microscope to exclude defects on the surface. To analyse the average roughness (Ra) of the polished composites a profilometer (Dektak 150, Veco Instruments, Tucson, USA) was used, as profilometry is a widely used method for roughness evaluation[10–13]. The average roughness (Ra) of a surface is defined as the average value of the height of the surface profile above and below a centreline throughout a prescribed sampling length. Ra is the major parameter reported.

For the surface scanning a 2.5 μm stylus-tip and a stylus angle of 90 degree were used, according to the composite roughness. The profilometer made 10 line scans on different locations for each sample. The beginnings and ends were not line scanned as many outliers were found at these sides.

## Results

Means and standard deviations of the surface roughness values (N, min., max., Ra) are shown in Table 3.

For both composites Sof-Lex fine and superfine discs produced a smoother final surface than Pogo. The finest surface was performed with the superfine (turquoise) Sof-Lex.

There was a significant difference in roughness ($p < 0.05$) between both composites demonstrated in Figure 1 (p-level demonstrated in Table 4).

The Ra results for the silorane composite were almost every time significantly higher than for the nanofill composites (t-test) Table 4 (Figure 2, 3, 4, 5).

**TABLE 3**
MEANS AND STANDARD DEVIATIONS OF THE SURFACE ROUGHNESS VALUES (N = NUMBER OF JAGS, MIN = MINIMAL HEIGHT OF JAGS, MAX = MAXIMAL HEIGHT OF JAGS, RA = AVERAGE ROUGHNESS)

| Composites | Polishing | N | Min. | Max. | Ra | Standard deviation |
|---|---|---|---|---|---|---|
| | Sof-Lex coarse | 2453 | 0.0018 | 12.300 | 0.992 | 1.266 |
| | Sof-Lex medium | 1572 | 0.0017 | 4.453 | 0.741 | 0.739 |
| Filtek Supreme XT | Sof-Lex fine | 1366 | 0.0001 | 7.302 | 0.293 | 0.445 |
| | Sof-Lex superfine | 553 | 0.0002 | 1.118 | 0.145 | 0.127 |
| | Pogo | 1228 | 0.0006 | 10.277 | 0.560 | 0.756 |
| | Sof-Lex coarse | 1279 | 0.0007 | 13.641 | 1.808 | 2.279 |
| | Sof-Lex medium | 2670 | 0.0042 | 25.892 | 1.170 | 1.288 |
| Filtek Silorane | Sof-Lex fine | 1773 | 0.0008 | 12.227 | 0.338 | 0.477 |
| | Sof-Lex superfine | 800 | 0.0000 | 2.199 | 0.126 | 0.142 |
| | Pogo | 1093 | 0.0037 | 27.590 | 1.005 | 1.667 |

## Discussion

This study evaluated the surface characteristics of two types of composite, one based on nano- and one on silorane technology.

**TABLE 4**
SIGNIFICANCE OF THE DIFFERENCE (T-TEST) BETWEEN FILTEK SILORANE AND FILTEK SUPREME XT DEPENDING ON THE POLISHER USED

| Polishing | t-test |
|---|---|
| Sof-Lex coarse | $p<0.001$ |
| Sof-Lex medium | $p<0.001$ |
| Sof-Lex fine | $p=0.007$ |
| Sof-Lex superfine | $p=0.012$ |
| Pogo | $p<0.001$ |

Under the conditions of this in vitro investigation, the smoothest polished surfaces were produced with the nanofill Filtek supreme, which combined long time polishing retention with good aesthetic aspects.

Also former studies showed that Sof-Lex discs provided smooth surfaces, due to their ability to cut the filler particle and the matrix in the same way[14–17].

Numerous studies have shown that when the polishing system and composite material come from the same manufacturer, its compatibility is better[18–20].

Profilometers have been used for years to measure surface roughness in in vitro investigations. With this method, however, the type and size of the stylus may have an effect on the roughness results, because the profilometer cannot picture surface features, which are narrower than the stylus tip[21]. It was therefore necessary to select a stylus tip, which was compatible with the mea-

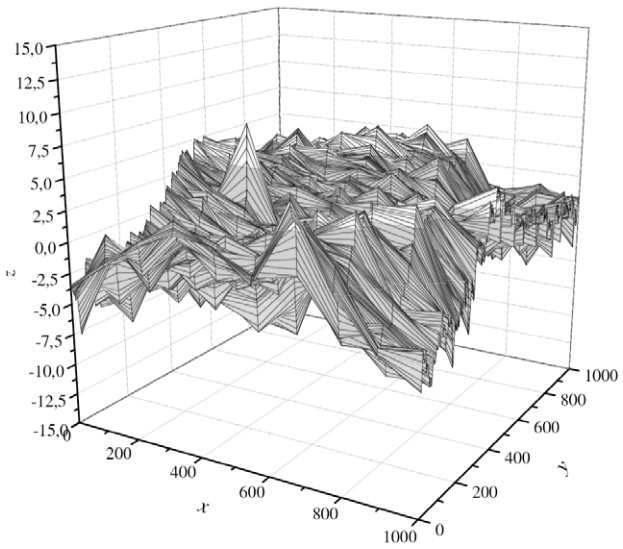


*Fig. 2. Filtek Silorane Sof-Lex medium.*

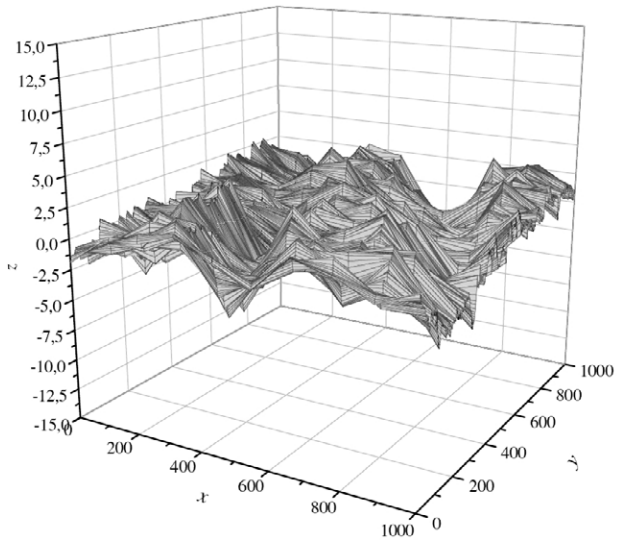


*Fig. 3. Filtek Supreme Sof-Lex medium.*


*Fig. 4. Profilometer Dektak 150 from Veco Instruments (overview).*

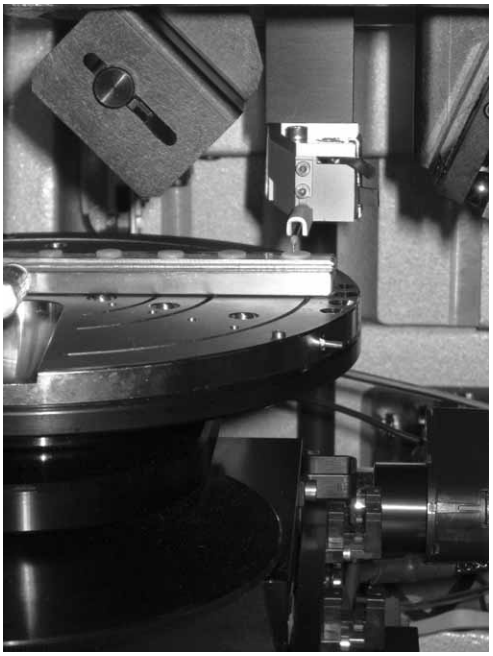

*Fig. 5. Profilometer Dektak 150 from Veco Instruments (detail).*

sured surface roughness or rather not to small to provide the dislocation capacity.

Korkmaz demonstrated that there is no difference between Pogo and Sof-Lex discs using Filtek Supreme[22]. Türkün indicated that Pogo exhibited a smoother finish in comparison to Sof-Lex discs[20].

Ideally polishing particles have to be harder than the filler particles to make sure to reduce the resin matrix and the fillers during polishing in the same way[23,24].

Sof-Lex discs are able to cut the fillers and the matrix almost similarly. For this reason Sof-Lex discs were used in this study, despite their limited application in the mouth, due to the complexity of the dental anatomy.

It has been shown that the critical limit of Ra is 0.2 μm over this data the risk of plaque accumulation, caries and gingival irritation increased[25]. In the current study all Ra values were under 0.2 μm.

For the clinician it is very important that the used composite combines several advantages like a smooth surface, strength or a minimal shrinkage. At the moment it is not possible that one composite can unify all advantages and exclude disadvantages.

On this account the clinician has to decide which composite features are needed for the restoration. The new silorane composite is a low shrink composite with also low water sorption, indicated for direct posterior restorations. On the other hand the nanofill composite is suitable for anterior and posterior restorations with good aesthetics demands and also good polish abilities.

The results of this in vitro survey showed that the surface roughness depends on both the composite and the polishing devices. Other studies confirm this conclusion[8,26,27].

## Conclusion

After polishing the smoothest surfaces were produced with nanofill Filtek Supreme XT. Furthermore, Sof-Lex fine and superfine discs produced a smoother surface than Pogo discs for both composites. Additional studies are necessary to determine surface roughness of new composites in comparison with commonly used composites.

To assure a perfectly smooth surface each composite should have its own polishing system according to its consistency.

### *Disclosure*

The authors do not have any financial interest in the companies whose materials were used in this study.

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## POVRŠINSKA HRAPAVOST NANOPUNILA I SILORANSKOG PUNILA NAKON POLIRANJA

## SAŽETAK

Cilj ovog istraživanja bilo je usporediti hrapavost površina jednog nanopunila (Filtek Supreme XT, 3M Espe, St. Paul, SAD) i jednog siloranskog punila (Filtek Silorane, 3M Espe, St. Paul, SAD) nakon poliranja. Pet uzoraka svakog punila polimerizirano je poliesterskim flasterom 40 sekundi. Nakon zacjeljivanja, četri uzorka polirano je različitim Sof-Lex diskovima, a jedan uzorak Pogo diskom 10 sekundi. Za učvrščivanje površine koristio se kontakni stylus-profilometar. Profilometar je ostavio deset tragova za svaki uzorak na različitim mjestima. Pokazala se statistički značajna razlika između oba punila. Prosječna površinska hrapavost (Ra) iloranskog punila gotovo uvijek je bila značajno viša od nanopunila (t-test). Za oba punila Sof-lex diskovi proizveli su finiju završnu površinu nego Pogo diskovi. Nanopunila pokazala su glađu površinu nakon poliranja i završnih procedura.