acta stomatologica croatica

Vol. 22, Br. 1

1988.

UDC 616.314-002-08
CODEN: ASCRBK
YUISSN: 0001—7019
Scientific paper

# INVESTIGATION OF SURFACE ROUGHNESS OF COMPOSITE FILLINGS

**Jozo Šutalo, Zoran Azinović, Marjan Tuđa,* Ivana Ciglar**

Department of Dental Pathology, School of Dentistry, University of Zagreb
Center for Research »Chromos« Zagreb*

Received: 13. 2. 1988.

**Summary**

Degree of surface roughness of five different composite materials for cavity fillings (Adaptic, Aurafill, Command, Heliosit and Silux) was assessed after mechanical finishing.

Various grinders (diamond and carbide burs, and soflex disks) were used in polishing the composite filling surfaces. Polishing was carried out 10 minutes and 14 days after the material polymerization. The ground surface was then observed by a scanning electron microscope and the surface roughness expressed in μm. Better surface polish and lower degree of roughness were observed when polishing was performed 14 days after polymerization. Best results were obtained in specimens polished by soflex disks and diamond burs.

**Key words:** roughness, composite

## INTRODUCTION

Owing to numerous good qualities which make them superior to classical materials for cavity fillings, the composite resins have been ever more widely used in therapeutic dentistry. During their development, these resins have passed through several phases, from classical macrofilled followed by microfilled composites and their combinations, the so-called hybrids, through recently developed microfilled complexes, loaded into an organic matrix in the form of prepolymerized splinted particles, lumpy or spherical particles (1, 2, 3, 4).

A feature common to composite materials is that they all require mechanical surface finishing, since the surface and marginal relations of fillings cannot be ideally fitted without subsequent polishing. Besides it, a smooth unpolished surface of the fillings contain, due to some

physical laws, a considerably large organic portion which wears away much faster leaving a rough surface thereafter. For these reasons, mechanical polishing is necessary to remove excess organic portion of the material and to leave a harder layer covering the surface, which will ensure a considerably higher surface resistance to mechanical wear, lower degree of heat expansion, better marginal closing and better esthetic appearance with less color change.

The aim of this study was to determine, in representative specimens, among five materials examined which showed the lowest degree of surface roughness after mechanical finish, among the instruments for final composite polishing provided best results, and what time point was most appropriate for finishing these materials.

## MATERIALS AND METHODS

The study was carried out on five different composite materials. Conventional macrofilled composites were repesented by Adaptic (Johnson-Johnson, USA), hybrids with a combination of large and small filler particles by Aurafill (Kerr, USA) and Command (LD Caulk, USA), and those with microfiller by Heliosit (Vivadent, Liechtenstein) and Silux (3M Products, USA).

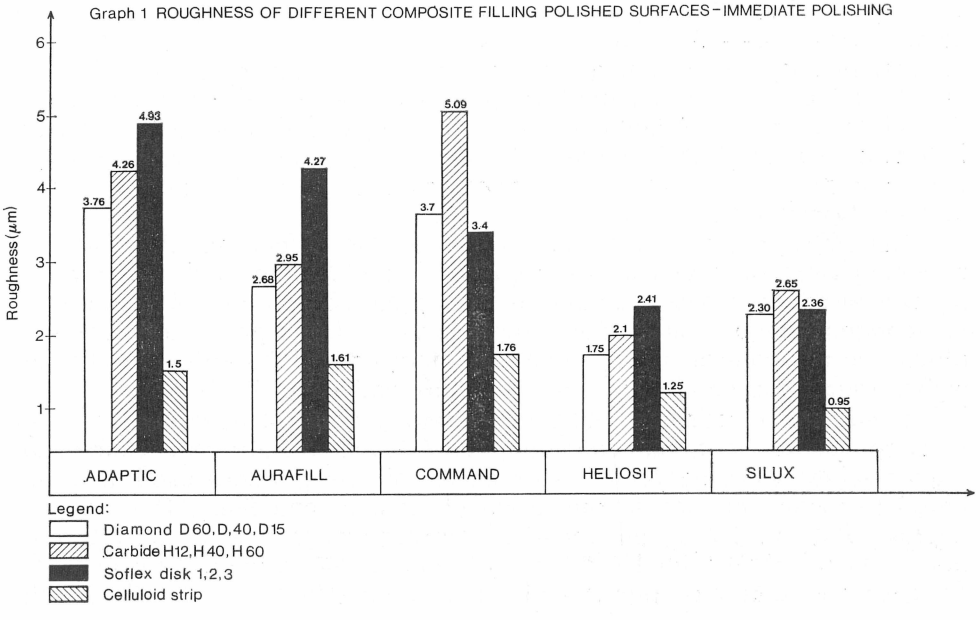
The study was done on 25 extracted permanent upper middle incisors. The specimens were cut across at the level of dental neck using a diamong disk. A cylindric diamong bur was used to prepare identical cavities on approximal surfaces beneath the contact point and on labial surface above the cementoenamel junction. Dimensions of the cavities were $3 \times 2$ mm. All cavities were washed and cleaned with Ahidron (Vivadent) and then air-dried. A composite was applied in each of the three cavities under same conditions, 0.2 mm above the level of the cavity, whereafter the tooth was wrapped up in a celluloid strip. The strip was allowed to stick to Adaptic for 5 minutes, i.e. until chemical polymerization was completed. In other cases, it was allowed to stay until the completion of photopolymerization only. Heliomat (Vivadent) producing halogenous light of a wavelength of 450—500 nm was used as a source of halogenous blue light. For all specimens, light exposure was 20 second per filling. The left and right sides were marked on each specimen. On the left side, all fillings were polished 10 minutes after polymerization, whereas on the right side they were polished 14 days later. Fillings on the labial surface were not mechanically polished and sereved as a control group. Mechanical finishing of a particular material always lasted 90 seconds with profuse moistening of the surface to avoid any interruption in the connection between filler particles and organic matrix due to elevated temperature.

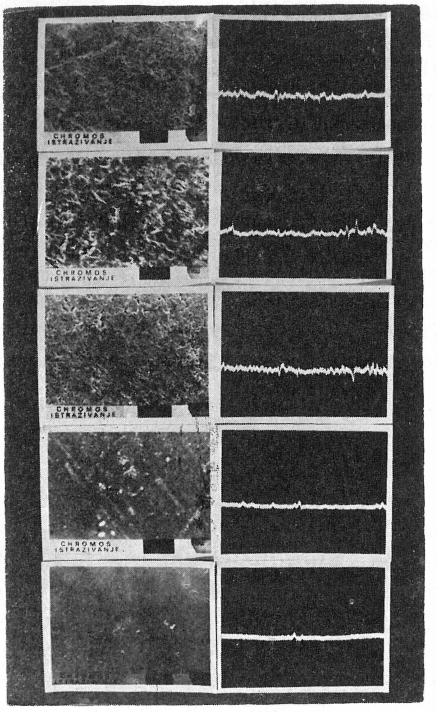
Finishing was carried out using various grinders: Composhape D-60, D-40 and D-15 diamond finishing burs, HF 12, HF 40 anad HF 60 carbide

tungsten cylindric burs, and Soflexs disks 1, 2, 3. The procedure of polishing lasted 30 seconds for each of the grinders used. After the completion of finishing, all specimens were washed with water and cleaned by Ahidron. The specimens thus prepared were then exposed to a special procedure of vacuumizing and gold vaporizing, and examined under a Cambridge Stereoscan 400 Scanning electron microscope at »Chromos Research Institute« in Zagreb. The so-called Y-modulation was employed in addition to the regular scanning technique. Using this procedure, the signal of the electron bundle being scanned produces an Y-shift, i. e. a deflection resulting in the appearance of a sinuous line of the light intensity bundle on the screen instead of dot-lines of different light intensities. In such a way, a track in the surface section profile was graphically magnified and then studied. Mean vaue to the surface roughness degree was expressed in μm.

## RESULTS

Upon the completion of the process of polymerization, mechanical finish of composite fillings was performed. All fillings on the left side of the specimens were polished 10 minutes after polymerization, whereas those on the right side were polished 14 days later. Fillings on the labial surface were not mechanically polished following removal of the celluloid strip, and served as a control group. In the control group,



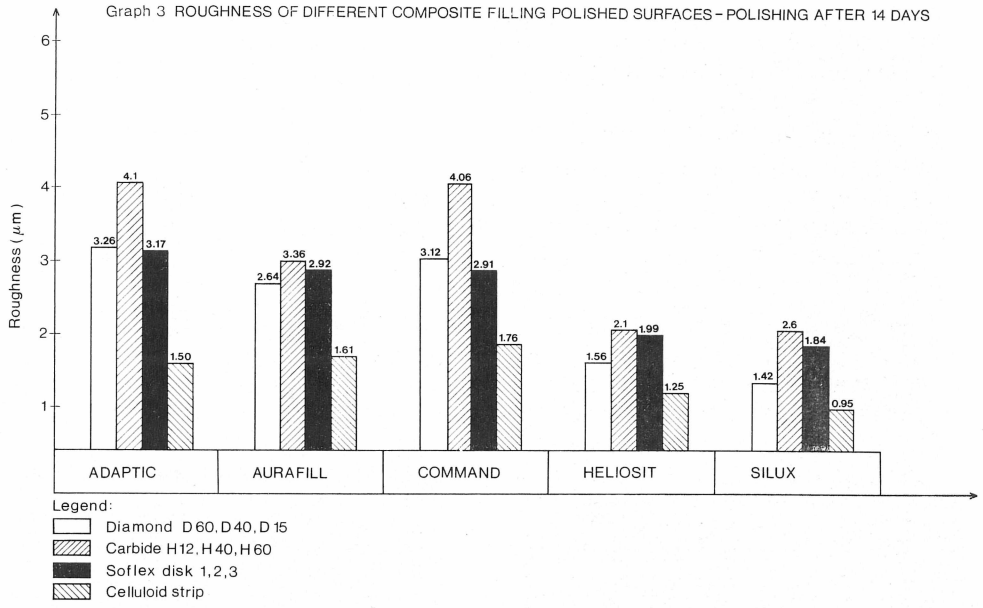


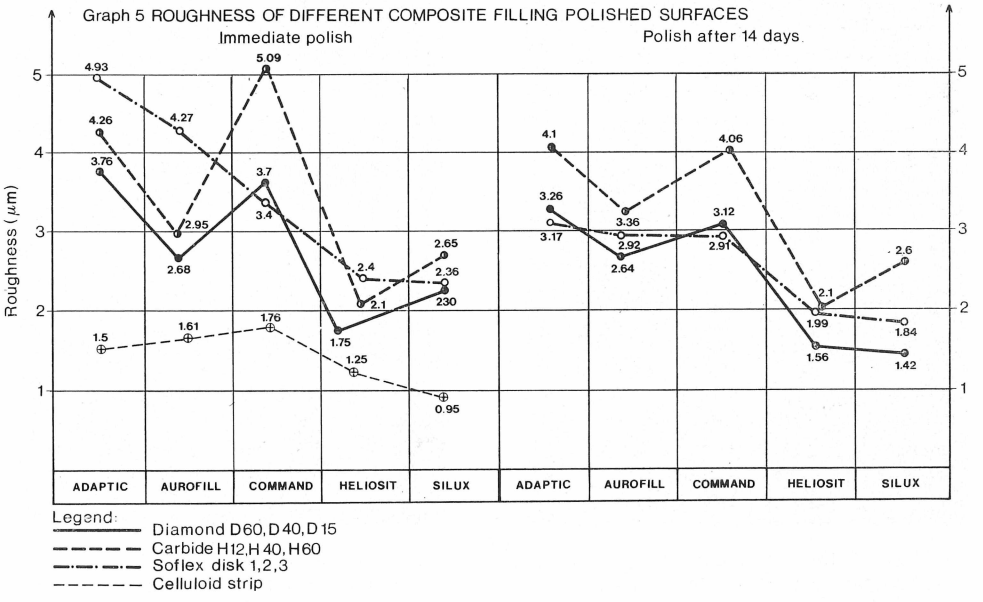
2 Surfaces of composite fillings (Adaptic, Aurafill, Command, Heliosit and Silux) in the control group without mechanical polishing.

ıe degree of roughness of composite filling surfaces of the five resins tudied was 0.95—1.767 μm, as shown in Graph 1 and Figure 2. Results f final mechanical polishing for the five composites studied, as assesed 10 minutes after polymerization, are presented in Figures 4,6 and , and in Graph 1. Adaptic showed the highest degree of roughness ollowing polishing with Soflex disks 1, 2, 3, whereas after polishing ith carbide cylindric burs the highest degree of roughness was recored for Command (5.09 μm).

Generally, higher values of the degree of roughness after surface olishing were observed in the group of Adaptic, Command and Aurafill, s compared to those recorded in the group consisting of microfilled omposites (Heliosit and Silux), regardless of the type of grinders emloyed. In the control group, Adaptic, Command and Aurafill also showed igher roughness degree values than Silux and Heliosit (Graph 1).

Results of mechanical polishing obtained after 14 days are depicted ı Graph 3. In the group consisting of Adaptic, Aurafill and Command, igher values were generally recorded for all the grinders used, as comared to those obtained in the group of Heliosit and Silux. The only exeption was an increased value of surface roughness in the Aurafill pecimen polished with HF 12, HF 40 and HF 60 carbide burs after 14 ays. In the group of microfilled composites (Heliosit and Silux) poli-



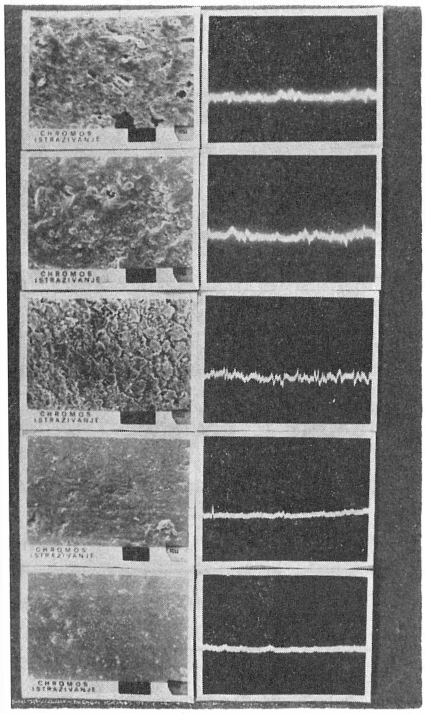




shed after 14 days, the degree of surface roughness was lower with all types of grinders. The lowest values of surface roughness were observed following polishing with Composhape D60, D40 and D15 diamond

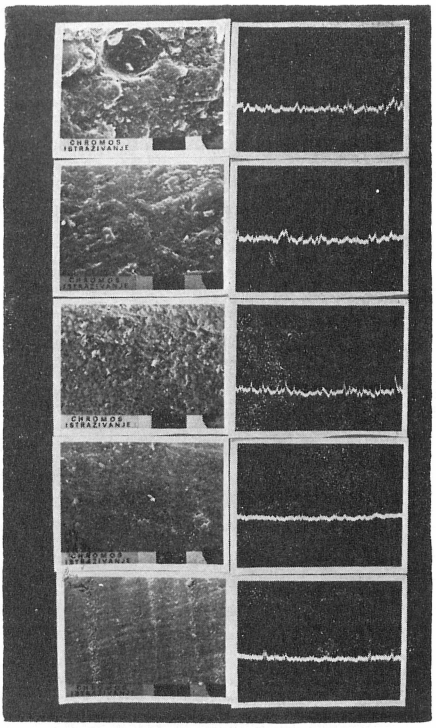
/lindric burs 14 days after polymerization. Heliosit and Silux exhibited ery similar values after polishing with diamond burs (1.56 μm and 1.42 n, respectively). The values obtained after polishing with carbide cylin- 1 μm), (Graph 3.)
ic burs were somewhat higher for Silux than for Heliosit (2.6 μm vs

In the group of classical composites (Adaptic) and hybrids (Aurafill ıd Command), a significant decrease in the values of surface roughness as observed after polishing with Soflex disks 1, 2, 3, 14 days after olymerization, as compared to the values obtained with mechanical po- sh 10 minutes after polymerization (Graph 5).

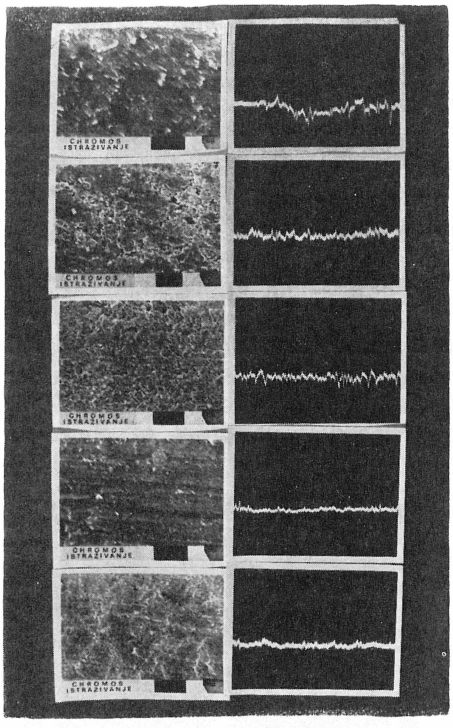
In general, lower values of surface roughness were also observed r Heliosit and Silux with all abrasive polishing instruments used. These ılues were still somewhat higher than those recorded for unpolished ırfaces in the control group of specimens.



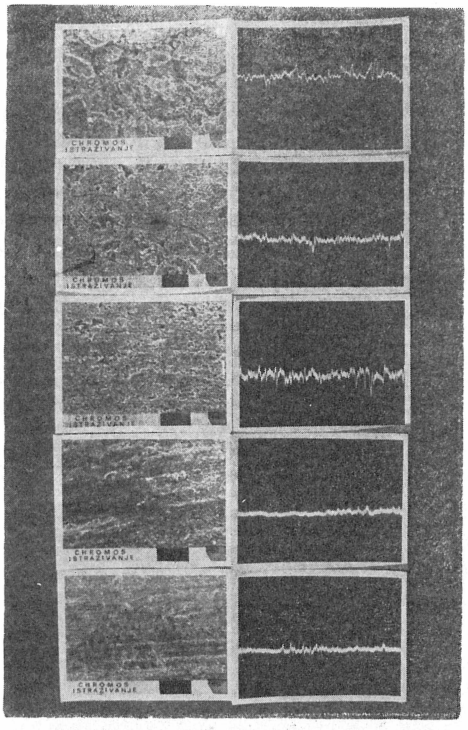
SEM of the composite filling surfaces (Adaptic, Aurafill, Command, Heliosit and Silux) by Y-modulation following polishing with HF12 and HF40 carbide grinders 10 minutes after polymerization.



6 SEM of the composite filling surfaces (Adaptic, Aurafill, Command, Heliosit and Silux) by Y-modulation following polishing with diamond finishing contour instruments 10 minutes after polymerization.



7 SEM of the composite filling surfaces (Adaptic, Aurafill, Command, Heliosit and Silux) by Y-modulation following polishing with Soflex disks 10 minutes after polimerization.



8 SEM of the composite filling surfaces (Adaptic, Aurafill, Command, Heliosit and Silux) by Y-modulation following polishing with carbide abrasive instruments 14 days after polymerization.

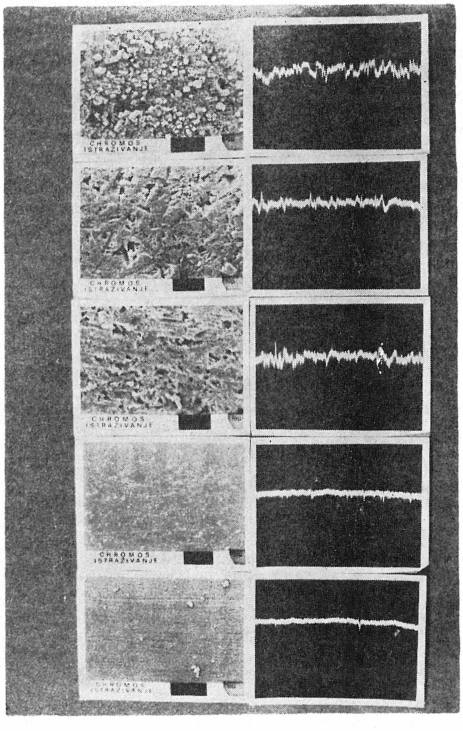
In the group of Heliosit and Silux specimens, polished after 10 minutes and after 14 days, the best results were recorded for polishing with Composhape D60, D40 and D15 diamond finishing disks, as presented in Graph 5. The scanning electron microscope analysis of surfaces of the five composite resins following polishing performed 10 minutes after polymerization and 14 days later, using various finishing instruments therebly, revealed the results of surface roughness to vary. The surface graphic profile was presented as an isolated continuous curve by Y-modulation. Employing this rpocedure, a track in the surface section profile was magnified, and the mean value of surface roughness mathematically calculated and expressed in μm.

Figures 8, 9 and 10 show the SEM display of surface roughness for the five specimens polished with differeit abrasive instruments, and a graphic presentation of the degree of surface roughness, obtained by »Y«-modulation.

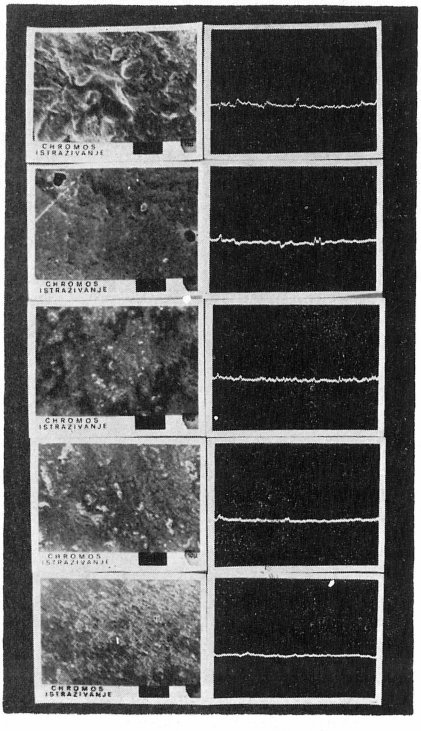
## DISCUSSION

The composite filling finish is of a great clinical importance, since a smooth, and polished surface plays a substantial role in the prevention of plaque accumulation and surface were, as well as in the marginal relation stability and color durability. In face of the fact that a celluloid strip provides the best surface, mechanical finishing of composite filling surfaces is recommended in every case because of difficulties encountered in adapting celluloid strip as precisely as not requiring subseqeunt polishing and adjustment of the marginal relations or the filling surface convex or concave contouring (5, 6, 7).

The surface structure complexity following mechanical finishing cannot be assessed on the basis of clinical observations or surface roughness measurements alone. For appropriate determination of surface roughness, also involving changes in the destructive effect of abrasive



9 SEM of the composite filling surfaces (Adaptic, Aurafill, Command, Heliosit and Silux) by Y-modulation following polishing with diamond abrasive instruments 14 days after polymerization.



10 SEM of the composite filling surfaces (Adaptic, Aurafill, Command, Heliosit and Silux) by Y-modulation following polishing with Soflex disks 14 days after polymeriaztion.

finishing grinders, the analysis of a scanning electron display of the surface, the surface profile and light refraction measurements also appear to be necessary (8, 9, 10, 11). Our study including polished surfaces of the five speciments of composite resins of various generations showed the surface roughness to be dependent of the type of composite, the time of final polish and the type of abrasive finishing instruments used.

Data analysis revealed the roughness degree of a surface polished 10 minutes after polymerization to be higher than that found in specimens polished 14 days later. Surface polishing by Composhape D60, D40 and D15 diamond contour finishing abrasive instruments resulted in the lowest degree of roughness in both groups (left and right) of specimens. An abrupt decline in the surface roughness values for both groups of specimens studied was also observed after polishing with Soflex disks 1, 2, 3, 14 days after polymerization. These data are consistent with the values reported on by O'Brien (12) et al. (1984), Eifinger (7) and Wilhelms (1984); Van Noort and Davis (13) (1984).

The composite filling surface polished by the HF 12, HF 40 and HF 60 carbide tungsten abrasive instruments showed the highest degree of roughness, i. e. the highest surface degradation in both groups of specimens studied, as seen in Graph 5 and Figures 8, 9 and 10. In both groups of specimens, the composite fillings with Heliosit and Silux yielded the lowest degree of roughness, regardless of the type of abrasive finishing instruments applied. Roughness of the surface polished with diamond finishing contour instruments 14 days after polymerization was observed to only slightly differ from that recorded in the control group of unpolished surfaces, as presented in Graph 5.

Composite microfilled resins have been generally shown to yield the lowest degree of surface roughness following mechanical polish with diamond finishing grinders and Soflex disks (7, 9, 13, 14).

Numerous studies have shown the best results of finishing procedure to be obtained with Soflex disks, with which the results of this study also agree to a great extent. Nevertheless, the fact should be emphasized that the Soflex disks are not suitable either for convex or concave surface polishing or for polishing the marginal parts of fillings adjacent to the gingiva.

According to our experience, in the parts of fillings that are difficult to access, better results can be obtained with diamond contour finishing instruments.

## CONCLUSIONS

The following conclusions can be made on the basis of the study of surface roughness of the five composite resins following mechanical

finishing with different abrasive instruments 10 minutes and 14 days after polymerization:

1. Differences in the surface roughness degree were observed between specimens polished immediately and 14 days after polymerization. Differences in the surface roughness degree were also observed after the use of different abrasive finishing instruments.

2. The control specimens not mechanically polished showed the lowest values of surface roughness.

3. The conventional composite specimens yielded the highest surface roughness edgrees with all the three types of abrasive instruments, followed by the hybrid group specimens, whereas the specimens from the group of microfilled composite resins exhibited the lowest surface roughness.

4. The lowest surface roughness degree, were achieved by polishing with Composhape D60, D40 and D15 diamond finishing contour instruments, immediately followed by the values obtained with Soflex disks 1, 2, 3 in the Heliosit and Silux specimens in both groups studied.

5. Surface polishing with HF 12, HF 40 and HF 60 hard-metal grinders revaeled the highest surface roughness degrees in all the specimens studied.

6. Following mechanical polishing, Heliosit and Silux microfilled composite resins exhibited the highest surface smoothness.

ISPITIVANJE HRAPAVOSTI POLIRANE POVRŠINE KOMPOZITNIH MATERIJALA

**Sažetak**

Stupanj hrapavosti površine pet različitih kompozitnih materijala za ispun kaviteta (Adaptic, Aurafill, Command, Heliosit, Silux) istraživan je nakon finalne obrade.

Za obradu površine kompozitnih ispuna korištena su različita brusna tijela (dijamantna, karbidna i soflex kolutovi). Obrada je izvođena 10 minuta nakon polimerizacije materijala i 14 dana kasnije. Površina izbruska promatrana je Scanning elektronskim mikroskopom, a stupanj hrapavosti površine izražen u μm. Zapažena je bolja poliranost površine i niži stupanj hrapavosti ako se obrada izvodi 14 dana nakon polimerizacije. Najbolje rezultate pokazuju uzorci koji su obrađivani soflex kolutovima i dijamantnim brusnim tijelima.

**Ključne riječi:** hrapavost, kompozitni materijali

**References**

1. GROSS M DOUGLAS WH FIELDS RP. The relationship between filler loading and particle-size distribution in composite resin technology J Dent Res 1983 62: 850
2. ST GERMAIN H, SCHWARTZ N, PHILLIPS RW, MOORE B, ROBERTS T. Properties of microfilled composite

relins as influenced by filler content, J Dent Res 1985; 64:155

3. TANI Y. Ein neuer submikrogefüllter Composite-Kunstoff Phillip J 1985; 2: :86
4. MICHOTTE TB. Choix d'un composite destine à la restauration des dents Rev Belg Med Dent 1986; 41:194
5. LUTZ F, SETOCS JC, PHILLIPS RW. New finishing instruments for composite resins J Am Dent Assoc 1983; 107:575
6. KREJCI I, LUTZ F. Kompositfüllungen Mschr Zahnmed 1984; 94:1015
7. EIFINGER FF, WILHELMS KG. Möglichkeiten der Oberflächebearbeitung von Composite-Füllungen Quintess 1984; 7:1289
8. PANTKE A, SCHÜTTLER D, HÜTTEMANN RW, PANTKE H. Vergleichende Untersuchungen verschiedener Methoden zur Beurteilung von Oberflächenstrukturen präparierter Zähne Dtsch Zahnärztl Z 1985; 40:386
9. REINHARDT JW, DENEHY GE, CHAN KC, RITTMAN BR, HEITKAMP DJ, SMTH TF. Determining smoothness of polished microfilled composite resins J Prosthet Dent 1983; 49:486
10. STANFORD WB, WOZNIAK WT, Fan PL, STANFORD JW. Effect of finishing on color and gloss of composites with different fillers J Am Dent Assoc 1985; 110:211
11. DAVIDSON CL. A'propos des resines composites a usage prosterieur Act Odont Stomat 1986; 153:9
12. O'BRIEN WJ, JOHNSTON WM, FANIAN F, LAMBERT S. The Surface Roughness and Gloss of Composites J Dent Res 1984; 63:685
13. VAN NOORT R, DAVIS LG. The Surface Finish of Composite Resins Restorative Materials Br Dent J 1984; 157:360
14. RAPTIS CN, FAN PL, POWERS JM. Properties of Microfilled and Visible Cured Composite Resins J Am Dent Assoc 1979; 99:931

**Obavještavamo članove Stomatološke sekcije ZLH-a, kao i sve liječnike — stomatologe da će se proslava 40-godišnjice Visokoškolske stomatološke nastave u SR Hrvatskoj održati u Staogradskoj vijećnici u Gornjem gradu dana 11. XI. 1988. u 9 sati.**

**Pozivamo sve zainteresirane da prisustvuju ovoj svečanosti.**