



M D J

Effect of Home Bleaching on Surface Roughness of Novel Composite Resins Subjected to One Step Polishing System: An In Vitro Study

Dr. Huda A Abdullah (B.D.S, M.Sc).*

Dr. Manal Hussain Abd-alla (B.D.S, M.Sc Ph.D).*

Dr. Sunds Hussein Naser (B.D.S, M.Sc.).*

Abstract

The aims of this in vitro study was to evaluate surface roughness (Ra) of four contemporary composite resin materials after applying home bleaching agent.

Materials and Methods: Forty-eight composite specimens were made from four groups of different types composite resins (one-submicron hybrid, one microhybrid and two nanohybrid) of 12 specimens each: Group 1: Brilliant EverGlow, group 2: G-aenial from GC, group 3: Evetric and group 4: Ice, SDI. All the samples were polished with one step polishing system OptraPol. Each group was further subdivided into two subgroups (A&B) (n=6). Subgroups A were stored in distilled water as control, while subgroups B were bleached with 20% carbamide peroxide home bleaching agent for 14 day. Surface roughness analysis was then performed for all the samples using atomic force microscopy (AFM). Results were statistically analyzed using One-way ANOVA/LSD test analyzing the differences between the subgroups at $p < 0.05$.

Results: Surface roughness of all the groups increased after bleaching; however, LSD test showed significant differences that were only recorded between the subgroups of groups 3 & 4.

Conclusion: 20% at-home bleaching treatment significantly affected surface roughness of both nanohybrid composite groups, while, it did not produce a significant surface changes for microhybrid and submicron composite resin.

Keywords: At home bleaching, surface roughness, contemporary composite resin.

Introduction

Pretty smile is considered an exceptionally serious subject nowadays. As esthetics being progressively more appreciated, practitioner dentists prefer to use resin composite material as a first choice in restorative field since these materials have both super appearance and appropriated mechanical properties⁽¹⁾.

Dental bleaching, on the other hand, has similar evolution in which it became in wide range types & techniques, and seems to be highly efficient and secure to treat teeth discoloration⁽²⁾. Since the introduction of at home bleaching technique by Haywood and Heymann in 1989, the development has become more trendy

*Almustansirya University/College of Dentistry.

⁽³⁾. Based on bleaching principle; hydrogen peroxide (HP) or its precursor, carbamide peroxide (CP) is an oxidizing agent that in contact with the tooth surface dissociates to produce unstable free radicals. These radicals attack the organic pigmented molecules by attacking double bonds of chromophore molecules within tooth tissues. The change in the double-bond conjugation results in smaller, less heavily pigmented constituents, thereby changing the color of the teeth ⁽⁴⁾. With the increasing demand for dental bleaching and esthetic valorization, several researchers have investigated the potential alterations resulting from the influence of bleaching agents on composite material. Different alterations have been reported such as increase in surface roughness, reduction in adhesive interface strength, decrease in microhardness and changes in opacity and color ⁽⁵⁾. Resin composite mechanical and aesthetic properties related mainly to their structure, also on the finishing and polishing aspects in which they have the importance of restoration success. Roughness of the composite surface causes debris adherence which resulted in bacterial plaque retention, that later may cause periodontal disease ⁽⁶⁾. Since finishing and polishing are important steps for reduction of plaque accumulation and decreasing discoloration of the restorations; as these procedures participate in recurrent caries & wear reduction, influence the marginal and periodontal integrity, thus ensuring the cosmetic restorations longevity ⁽⁷⁾. Bleaching materials effects on the properties of restorative materials after polishing step is an essential issue, hence numerous researches have evaluated its consequence both on the physical and mechanical properties of tooth colored restorations⁽⁸⁻¹²⁾. **Attin et al in 2004** in their review on the effect

of bleaching agents on dental restorative materials indicated that bleaching may exert a negative impact on existing restorations⁽⁸⁾. **Hannig et al in 2007** reported that bleaching with the tested bleaching agents softens the adhesive restorative materials examined. Polishing of the surface may not suffice for re-establishing the physical properties of the surface of the fillings due to the fact that subsurface layers are also affected⁽⁹⁾. **Yu H et al. in 2008** evaluated the effects of a home bleaching gel containing 15% carbamide peroxide on the surface microhardness of four tooth-colored restorative materials in situ ;they reported effects of 15% CP on surface microhardness were material dependent⁽¹⁰⁾. In a study of **Atali and Topbasi in 2011** using a 2-week bleaching regimen with high peroxide concentrations either in a dental office or at home, they showed that the bleaching agents used affected the roughness and hardness of hybrids, nano hybrids, nano super filled, and silorane composites⁽¹¹⁾. **Cengiz et al. in 2016** concluded that there was no significant difference between Ra values after HP and CP application within five composite groups while SEM micrographs showed higher surface alterations with HP group compared to CP⁽¹²⁾. However, up-to-date no study has investigated the surface roughness of recently marketed novel composite materials in association with at-home bleaching agents after polishing with one step polishing system OptraPol using AFM device. Therefore, the aim of the current in vitro study was to evaluate the effect of 20% CP at home bleaching agent on surface roughness of one submicrom hybrid, one micrhybrid and two nanohybrid composite resin after polishing with one step polishing OptraPol polishing system.

Materials and Methods

Forty eight samples from four recently marketed composites materials (**Figure 1**) were prepared to form four groups, twelve specimens of each composite material, as follow:

Group 1: (BRILLIANT EverGlow, Coltène/Whaledent AG), a universal submicrom hybrid composite resin.

Group 2: (G-aenial from GC, GC Corp., Tokyo, Japan), a microfilled hybrid composite resin.

Group 3: (Evetric, Ivoclar Vivadent AG), a nanohybrid composite resin.

Group 4: (Ice, SDI , North America Inc), a nanohybrid composite resin.

The samples were made by packing the composite resin into a plastic mold (8 mm diameter × 2 mm thick) ⁽¹³⁾ (**figure 2**) which were positioned on a mylar strip. Removing the excess composites material, using another mylar strip on top of the mold in order to obtain smooth publishable surface and then pressed flat with a glass slab. All samples were light-cured for 20 seconds from both top and bottom surfaces using light cure device (light output (850-1000mW/cm²), (Guilin Woodpecker, China) according to instructions of the manufacturer. All samples were then polished using one step OptraPol (Ivoclar-Vivadent AG). The disc shape of OptraPol was used with moderate pressure for 15 sec for each sample. The samples were then stored in 100% humidity at 37°C. The samples of the four groups were then subdivided into subgroups(A) (n=6); serves as control and stored in distilled water for 14 days, while subgroups (B) were treated with 20% CP Opalescence PF at home bleaching agent (Ultradent Product, South Jordan, UT, USA) for two weeks in a humid environment. The bleaching agent was applied onto the samples for

2 hour daily according to the manufacturer's instructions. After the bleaching time all the samples were washed out under running water to remove any bleaching agents residue and then stored back in distilled water for the rest of the day at room temperature. By the end of the bleaching regimen, the surface roughness test (Ra) was performed using atomic force microscopy in the exact center of the specimen at (25 × 25) µm surface area was inspected. The data were collected from all groups and their subgroups and results were statistically analyzed using LSD in One-way ANOVA tests at p<0.05

Results

Mean and standard deviation of all experimental groups were shown in (**Table1**). Group 3 without bleaching has the least surface roughness value measured by AFM, followed by group 1, the highest surface roughness value seen in group 2.

multiple comparison in One way ANOVA test of total RA (LSD test) was used among all subgroups and revealed that group 1 & 2 had non significant difference in (control and 20% CP group), but group 3 & 4 had been significant different (**Table 2**).

Surface roughness topography picture of each control and bleached groups of four material specimen from each group shown in (**figure 4**).

Discussion

After dental bleaching, evaluations of composite restorations characteristics, such as surface roughness, marginal integrity and color change are considered necessary parameters. Surface roughness is critical in which it has maintenance representation as its effect may lead to composite resin wear and

discoloration. On the other hand, the biological effect of surface roughness to the periodontium, particularly the occurrence of gingivitis and secondary caries may appear after CP bleaching⁽¹⁴⁾.

AFM cantilever sensor has been used to record any irregularity at composite surface. However, all the composites samples were polished with the same polishing system (one-step OptraPol disks) in order to achieve surface finish similarity before bleaching treatment. In this study, two of study groups were statistically non significant but at the same time group A which represent restoration roughness without bleaching have Ra values lower than that of group B⁽¹¹⁾. This will be agree with recently reported research assuming that bleaching may cause increased surface roughness on composite materials⁽¹⁵⁾. As seen in subgroups of groups 3&4; in which it was significantly different $p < 0.05$; bleaching agents may resulted in a softening and reduction in micro-hardness and free radicals induced by peroxides may affect the resin-filler-interface and cause filler-matrix debonding⁽¹⁶⁾. In other words, explanation of increasing Ra in post bleaching group was that; as bleaching agent used in the study was CP- based, which breaks down into urea and hydrogen peroxide. This in turn forms free radicals that can eventually form water and accelerate the hydrolytic degradation of the composite, resulting in bonding failure between the resinous matrix and load particles, increasing the surface roughness of the composite⁽¹⁷⁾. Another parameter explain increase of surface roughness in these nanohybrid groups was related to increase of monomer or matrix elution; water accumulated at the aggregated zirconium/silica cluster filler-organic matrix interface this can create paths in nanofilled composite

for water diffusion towards the inside of aggregates, where probably microvoids are present, due to lack of 5–20 nm-sized primary in the polymeric matrix particles may be impregnated⁽¹⁸⁾. The diffusion occurred in a Part of absorbed water in composites through the network and is trapped in polymer nano-voids; so the amount of absorbed water dictated the total void amount in the polymer network⁽¹⁹⁾.

Initially, polymer softening caused by water sorption as a result of reducing the frictional forces between the polymer network⁽²⁰⁾. unreacted monomers trapped in the polymer chains are released at a rate controlled by the relaxation capacity and polymer's swelling⁽²¹⁾. This phenomenon possibly explains the greater release of monomers from nanofilled composite⁽²²⁾. But this increase in Ra after bleaching statistically non significant different as previously mentioned in other two subgroups.

In which group 1 (Brilliant ever glow which was considered submicron hybrid composite) had close result Ra values in both subgroups that mean bleaching agent didn't affect composite polished surface in which this will make the material to be valuable & good quality characteristic feature as it had 74% inorganic filler by weight and had filler size of about 20-1500 nm which considered as highly filled composite type⁽²³⁾. The inorganic content of resin composites however, offers resistance to bleaching. shape, distribution and amount of fillers are all aspects that determine the clinical performance of these restorative materials^(24,25). Despite advances in the evolution of composites, no material yet exists that is totally resistant to erosion/corrosion. Recent studies have reported that the durability of resin-based materials can be assured by

polishing the restorations after bleaching^(26,27). As

Wattanapayungkul and others in 2004 suggested that differences between the materials could be a result of the difference in resin matrix components and filler size⁽¹⁶⁾.

Group 2 G-aenial which is microfilled hybrid composite type the results were non significantly affected by bleaching which is come to be agree with **Turker and Biskin in 2003**, research findings showed that the surface roughness of the microfilled composite was not affected by different CP concentrations⁽²⁸⁾. Studies had been suggested that roughening can be resulted from the loss of matrix, rather than filler particles^(29,30).

In control group, the least Ra value was recorded for nanohybrid composite evetric group. This result is in accordance with the results reported by **Ergücü et al in 2008**; they suggested that One-step polishing systems could be used successfully for polishing nanocomposites⁽³¹⁾. Nano-sized particles composites can retain a uniform texture after polishing process (Filler loading 80-81 wt. %, 55-57 vol. %). The adequate polishing protocols have a major role in the final surface quality⁽³²⁾. However, final surface texture is material and technique dependent^(33,34).

All groups Ra values were under 1µm ; As to Chung in 1994 study, when Ra was lower than 1µm, smooth surfaces were visibly seen. As a result, all composites resin material surfaces evaluated after bleaching treatment have verified a smooth surface, which from the clinical point of view, there were no risk of increase of plaque accumulations^(35,36). It is essential to note that this is an in vitro study, with its limitations, only the surface roughness of composite materials was determined & evaluated, without concerning with aesthetic factors;

composite restorations color which probably affected by bleaching^(37,38).

Conclusion

Within the limitations of the current study, it can be concluded that:

- 1- The effect of 20% CP home bleaching agent on the surface roughness of tooth-colored restorative materials is material dependent.
- 2- 20% CP home bleaching agent home bleaching increased Ra of polished surface of - nanohybrid composite groups. However, it did not affect the polished surface of neither Brilliant, nor G-aenial composite resin materials.

References

- 1- Mitra SB, Wu D, Holmes BN. An application of nanotechnology in advanced dental materials. J Am Dent Assoc 2003; 134: 1382-90.
- 2- Kwon SR. Whitening the single discolored tooth. Dent Clin North Am. 2011; 55: 229-39.
- 3- Haywood VB, Heymann HO. Nightguard vital bleaching. Quin Int 1989;20:173-6.
- 4- Costa SX, Becker AB, Rastelli AN, Loffredo LC, Andrade MF, Bagnato VS. Effect of four bleaching regimens on color changes and microhardness of dental nanofilled composite. Int J Dent 2009; 31: 38-45.
- 5- Gouveia THN, Públio J do C, Ambrosano GMB, Paulillo LAMS, Aguiar FHB, Lima DANL. Effect of at-home bleaching with different thickeners and aging on physical properties of a nanocomposite. Euro Journal of Dent 2016;10(1):82-91.
- 6- Aykent F, Yondem I, Ozyesil AG, Gunal SK, Avunduk MC, Ozkan S. Effect of different finishing techniques for restorative materials on surface roughness and bacterial adhesion. J Pros Dent 2010;103:221-7.
- 7- Rai R, Gupta R. In vitro evaluation of the effect of two finishing and polishing systems on four esthetic restorative materials. J Conserv Dent 2013;16:564-7.
- 8- Attin T, Hannig C, Weigand A, Attin R. Effect of bleaching on restorative

- materials and restorations – a systematic review. *Dent Mater* 2004; 20: 852-61.
- 9- Hannig C, Duong S, Becker K, Brunner K, Kahler E, Atin T. Effect of bleaching on subsurface micro-hardness of composite and a polyacid modified composite. *Dent Mater* 2007 ; 23: 198–203.
 - 10- Yu H, Li Q, Hussain M, Wang Y. Effects of bleaching gels on the surface microhardness of tooth-colored. *J Dent*. 2008;36:261–7.
 - 11- Pinar Yilmaz Atali* and Faik Bülent Topbai. The effect of different bleaching methods on the surface roughness and hardness of resin composites. *J Dent Oral Hyg* 2011; 3(2), 10-17,
 - 12- Cengiz E, Kurtulmus-Yilmaz S, Nuran Ulusoy, Sule Tugba Deniz, Ece Yuksel-Devrim. The effect of home bleaching agents on the surface roughness of five different composite resins: a SEM evaluation. *J Scanning Micro* 2016; 38, 277–283.
 - 13- Meena C Kumari, Manohar K Bhat, and Rahul Bansal. Evaluation of surface roughness of different restorative composites after polishing using atomic force microscopy. *J Conserv Dent* 2016; Jan-Feb; 19(1): 56–62.
 - 14- Dutra RA, Branco JR, Alvim HH, Poletto LT, Albuquerque RC. Effect of hydrogen peroxide topical application on the enamel and composite resin surfaces and interface. *Indian J Dent Res*. 2009; 20: 65-70.
 - 15- Yu H, Li Q, Wang YN, Cheng H. Effects of temperature and in-office bleaching agents on surface and subsurface properties of aesthetic restorative materials. *J Dent* 2013; 41: 6-90.
 - 16- Wattana payungkul P, Yap AUJ, Chooi KW, Lee MFLA, Selamat RS, Zhou RD. The effect of home bleaching agents on the surface roughness of tooth colored restoratives with time. *Oper Dent* 2004; 29: 398-403.
 - 17- Rattacaso RMB, da Fonseca Roberti Garcia L, Aguilar FG, Consani S, de Carvalho Panzeri Pires-de-Souza F. Bleaching Agent Action on Color Stability, Surface Roughness and Microhardness of Composites Submitted to Accelerated Artificial Aging. *Euro Jour of Dent* 2011;5(2):143-149.
 - 18- Santos C, Clarke RL, Braden M, Guitian F, Davy KWM. Water absorption characteristics of dental composites incorporating hydroxyapatite filler. *Biomaterials*. 2002;23:1897–1904.
 - 19- da Silva EM, Almeida GS, Poskus LT, Guimarães JG. Relationship between the degree of conversion, solubility and salivary sorption of a hybrid and a nanofilled resin composite: influence of the light-activation mode. *J Appl Oral Sci*. 2008;16:161–6.
 - 20- Ferracane JL, Berge XH, Condon JR. In vitro aging of dental composites in water-effect of degree of conversion, filler volume, and filler/matrix coupling. *J Biomed Mater Res*. 1998;42:465–72.
 - 21- Moharamzade K, VanNoort R, Brook IM, Scutt AM. HPLC analysis of components released from dental composites with different resin composition using different extraction media. *J Mater Med*. 2007;18:133–137.
 - 22- Tabatabaee MH, Arami S, Ghavam M, Rezaii A. Monomer Release from Nanofilled and Microhybrid Dental Composites after Bleaching. *J Den (Tehran)*. 2014;11(1):56-66.
 - 23- Bogdan r. Shumilovich, andrey v. Sushenko, alexey n. Morozov, elena a. Lesh-cheva voronezh n.n .New submicron composite brilliant everglow from coltene – innovative approach to the restoration of teeth. Composite of the future – physical properties, clinical features. *Burdenko stat med univ* 2016;5.
 - 24- Wang L, Garcia FCP, Araujo PA, Franco EB, Mondelli RFL. Wear resistance of packable resin composites after simulated toothbrushing test. *J Esthet Restor Dent*. 2004;6:303–315.
 - 25- Badra VV, Faraoni JJ, Ramos RP, Palma-Dibb RG. Influence of different beverages on the microhardness and surface roughness of resin composites. *Oper Dent*. 2005;30:213–219.
 - 26- Polydorou O, Hellwig E, Auschill TM. The effect of different bleaching agents on the surface texture of restorative materials. *Oper Dent*. 2006;31:473–480.
 - 27- Yazici AR, Tuncer D, Antonson S, Onen A, Kilinc E. Effects of delayed finishing/polishing on surface roughness, hardness and gloss of tooth-coloured restorative materials. *Eur J Dent*. 2010;4:50–56.
 - 28- Turker, S. B. and T. Biskin .. Effect of three bleaching agents on the surface properties of three different esthetic restorative materials. *J of Pros Dent* 2003;89(5):466–473.
 - 29- Bailey, S. J. and E. J. Swift Jr . Effects of home bleaching products on composite resins. *Quint Inter* 1992;23(7):489–494.

- 30- O. Polydorou, E. Hellwig, and T. M. Auschill (2006) The Effect of Different Bleaching Agents on the Surface Texture of Restorative Materials. *Oper Dent* 2006;31(4):473-480.
- 31- Ergücü, Türkün & Aladag: Color Stability of Nanocomposites Polished with One-Step Systems .*Operative Dentistry* 2008, 33-4, 413-420
- 32- Tijana Lainović, Larisa Blažić, Dragan Kukuruzović, Marko Vilotić, Aljoša Ivanišević, Damir Kakaš. Effect of Diamond Paste Finishing on Surface Topography and Roughness of Dental Nanohybrid Composites – AFM Analysis. *Procedia Engin* 2014 ;699 :45 – 951.
- 33- Vera LS, Regina MP, Fabiana SN, Flavia PSN, Mario ACS, Wagner B. Effect of the polishing procedures on color stability and surface roughness of composite resins. *Inter Schol Research Network ISRN Dent* 2011; 10: 1-6.
- 34- Media A. Saeed ,Intesar S. Toma , Razawa K. Saeed .The effect of two finishing and polishing systems on the surface roughness of two composite resins .*Zanco J Med. Sci* 2013; 17,(3).
- 35- Chung KH. Effects of finishing and polishing procedures on the surface texture of resin composites. *Dent Mater* 1994;10:325-30.
- 36- Zuryati AG, Qian OQ, Dasmawati M. Effects of home bleaching on surface hardness and surface roughness of an experimental nanocomposite. *J Conserv Dent* 2013;16:356-61.
- 37- Canay S, Cehreli MC. The effect of current bleaching agents on the color of light-polymerized composites in vitro. *J Prosthet Dent* 2003; 89: 474-8.
- 38- Bruna Fortes Bittencourt, Giovana Mongruel Gomes, Felipe Auer Trentini, Mônica Regina de Azevedo, João Carlos Gomes, Osnara Maria Mongruel Gomes .Effect of finishing and polishing on surface roughness of composite resins after bleaching. *Braz J Oral Sci* 2014;13(2):158-162.

Tables

Table 1. Mean values of surface roughness for all groups

Groups		Means (μm)	Std. Dev.
G1	A(control)	0.53	0.09
	B(bleached)	0.63	0.04
G 2	A(control)	0.86	0.11
	B(bleached)	0.90	0.06
G3	A(control)	0.23	0.04
	B(bleached)	0.73	0.16
G4	A(control)	0.56	0.18
	B(bleached)	0.85	0.04

Table .2results taken from LSD test among all subgroups

Sig	P value	CP Group B	Control Group A
N.S	0.584	1	1
N.S	0.539	2	2
H.S	0.000	3	3
H.S	0.000	4	4

***Highly significant difference; N.S Non-significant difference

Figures



Figure 1. Four types of composite materials used



Figure 2. Cylinder shape sample material

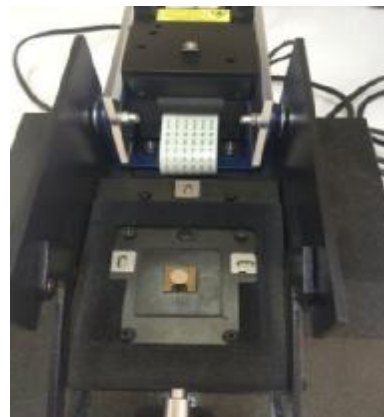
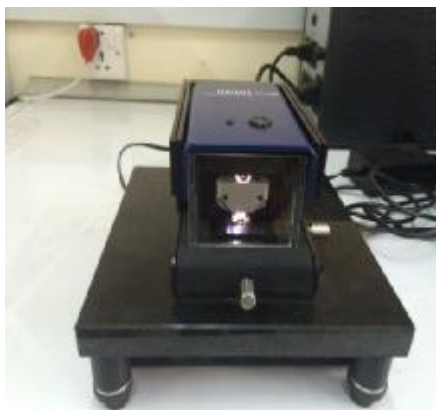


Figure 3. Sample positioned inside AFM device

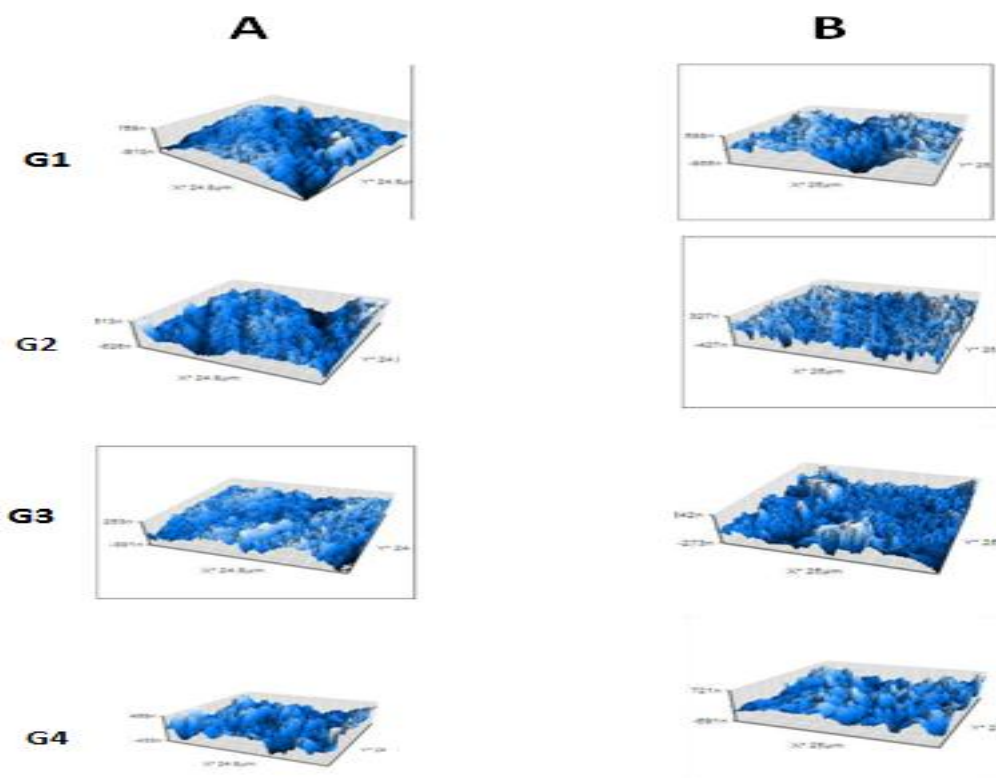


Figure 4 A: Ra topography in control group B: Ra topography in bleached group