CHAPTER 4

RESULTS

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4.1 Surface microhardness

4.1.1 Control group

The means and standard deviations of surface microhardness (VHN) of different composites in the control group was presented in Figure 4.1 The mean VHN for TPH Spectrum was 73.06, Filtek Z350 was 92.63, Ceram•X Mono was 79.44 and Ceram•X Duo-enamel shade was 72.83. Filtek Z350 had the highest mean VHN and Ceram•X Duo-enamel shade has the lowest mean VHN in control group.
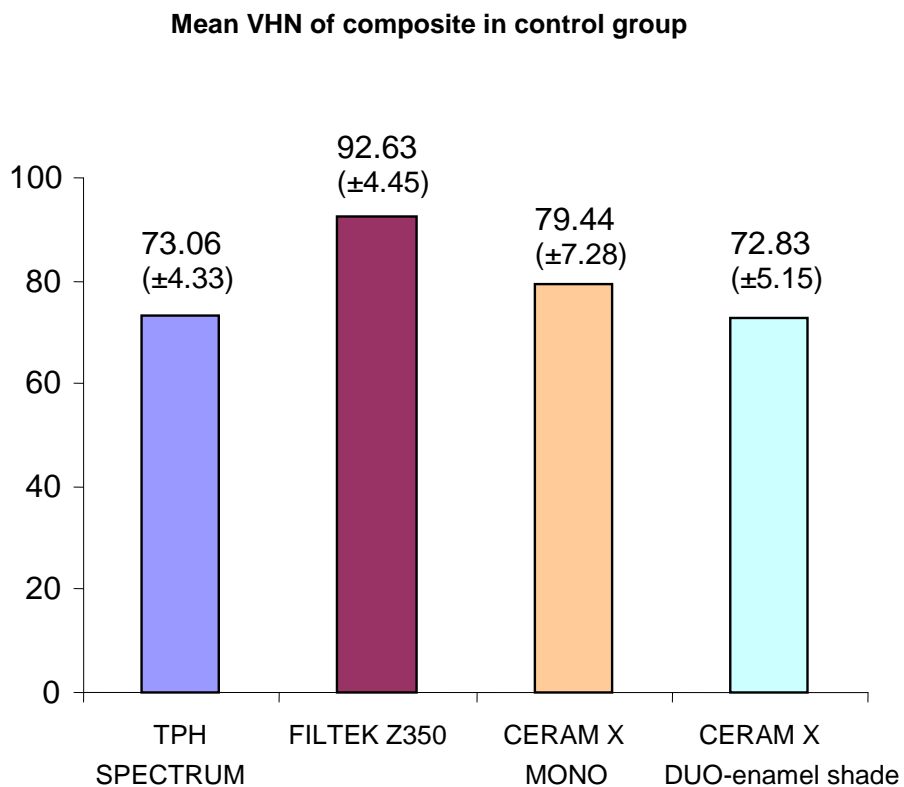
Mean VHN of composite in control group

Figure 4.1   Mean VHN of composites in control group

4.1.2　Test groups compared with control group

Table 4.1 illustrated the mean VHN of different composites in various mouthrinses. The mean VHN of control group (before immersion) of all composites showed higher VHN compared to mean VHN after immersion except Ceram•X Duo. For TPH Spectrum, specimens immersed in Listerine showed the lowest mean VHN (65.54) and specimens in distilled water showed the highest mean VHN (70.71). Specimens in Listerine for Filtek Z350 also showed the lowest mean VHN (84.36) and in distilled water showed the highest mean VHN (88.68). For Ceram•X Mono, specimens in mouthrinses Z showed the lowest mean VHN (68.99) and specimens in Oral B showed the highest mean VHN (78.67). Specimens in distilled water for Ceram•X Duo-enamel shade showed the lowest mean VHN (69.74) and specimens in mouthrinses X showed the highest mean VHN (74.57).

Table 4.1　Mean VHN and standard deviation of composites before and after immersion in different mouthrinses

Mouthrinses / Composites	Before immersion	After immersion					
	Control group	Listerine	Oral B	Mouth rinses X	Mouth rinses Y	Mouth rinses Z	Distilled Water
TPH Spectrum	73.06 (±4.33)	65.54 (±4.04)	67.69 (±4.23)	69.33 (±4.78)	67.47 (±3.77)	68.65 (±3.02)	70.71 (±5.28)
Filtek Z350	92.63 (±4.45)	84.36 (±3.82)	85.82 (±7.18)	88.04 (±3.69)	88.34 (±1.72)	89.04 (±2.19)	88.68 (±3.14)
Ceram•X Mono	79.44 (±7.28)	77.07 (±9.22)	78.67 (±6.96)	70.96 (±5.49)	71.14 (±5.62)	68.99 (±4.62)	77.23 (±3.47)
Ceram•X Duo enamel shade	72.83 (±5.15)	70.29 (± 5.84)	71.86 (±4.37)	74.57 (±5.47)	71.56 (±3.30)	74.50 (±2.49)	69.74 (±4.54)

4.2   Statistical analysis

4.2.1   Preliminary analysis of control group

Before carrying out the one-way ANOVA, it was essential that the data were subjected to preliminary analysis. This was to investigate the presence of extreme values in the data and to check whether the shape of the distributions for the respective groups approximate normality. The analysis was conducted using the SPSS Explore procedure. The results of the analysis indicate that the distributions for the four groups before immersion approximate the normal distribution as the skewness and kurtosis values for the groups are between -1 and +1 (Table 4.2). The Ceram•X Mono group, however, shows a slightly high skewness value (1.15) and a slightly high kurtosis value (1.18). Nonetheless, this value is still within the acceptable range as suggested by Tabachnick and Fidell, (2001).

Table 4.2   Skewness and kurtosis values of VHN of different groups of composite

before immersion

	TPH Spectrum	Filtek Z350	Ceram•X Mono	Ceram•X Duo (enamel shade)
Skewness	0.37	0.95	1.15	0.56
Kurtosis	-0.56	-5.9	1.18	0.50

4.2.2 Statistical analysis of control group

Comparison of the mean values of hardness between the four composites in control group is displayed in Table 4.3.

Table 4.3 Mean VHN and standard deviation for different composites in control group (before immersion)

Composites	Mean VHN	N	Std. Deviation
TPH SPECTRUM	73.06	60	4.33
FILTEK Z350	92.63	60	4.45
CERAM•X MONO	79.44	60	7.28
CERAM•X DUO-enamel shade	72.83	60	5.15

Table 4.4 One-way ANOVA for composites in control group

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	15501.833	3	5167.278	175.075	.000
Within Groups	6965.442	236	29.515		
Total	22467.275	239			

One-way ANOVA showed that there was significant different in surface microhardness between the four types of composites in control group (Table 4.4). Levene's test indicate that the assumption of homogeneity of variance is not met (Table 4.5). As this assumption is not met, Games Howell was chosen as the post hoc test to show the difference between groups and it illustrate significant difference between all composites except for TPH Spectrum and Ceram•X Duo-enamel shade (Table 4.6).

Table 4.5   Levene's test of homogeneity of variances

Levene Statistic	df1	df2	Sig.
4.299	3	236	.006

Table 4.6   Games-Howell multiple comparisons test between composites in control group

(I) COMPOSITE	(J) COMPOSITE	Mean Difference (I-J)	Sig.
TPH SPECTRUM	FILTEK Z350	-19.5683(*)	.000
	CERAM•X MONO	-6.3733(*)	.000
	CERAM•X DUO	.2333	.993
FILTEK Z350	TPH SPECTRUM	19.5683(*)	.000
	CERAM•X MONO	13.1950(*)	.000
	CERAM•X DUO	19.8017(*)	.000
CERAM•X MONO	TPH SPECTRUM	6.3733(*)	.000
	FILTEK Z350	-13.1950(*)	.000
	CERAM•X DUO	6.6067(*)	.000
CERAM•X DUO enamel shade	TPH SPECTRUM	-.2333	.993
	FILTEK Z350	-19.8017(*)	.000
	CERAM•X MONO	-6.6067(*)	.000

* The mean difference is significant at the .05 level.

4.2.3   Randomizing of data for the control group

There were 60 mean VHN readings of each composite which were computed giving a total of 240 VHN initial readings as the readings were done for every specimen before immersion in various mouthrinses and distilled water. Therefore, 60 readings from each composite were randomized to obtain only 10 readings from each composite using SPSS Version 13.0 software. Data for each composite was analyzed using one-way ANOVA and the result showed that there was no significant difference in the mean VHN in all groups except for Ceram•X Mono , p= .004 (Table 4.7).

Table 4.7   p value for each composite (ANOVA)

Composite	P value
TPH Spectrum	0.404
Filtek Z350	0.099
Ceram X•Mono	0.004
Ceram X•Duo enamel shade	0.345

Exploration of data revealed three outlier values for composite Ceram•X Mono and these data was removed. The data were then reanalyzed and ANOVA showed no significant difference (p= 0.274) between means in the group. Following this procedure data from the control group was randomized using SPSS version 13 and 10 readings were selected for each composite.

4.2.4   Statistical analysis of test group against the control group

Dunnet-t double sided test showed mean VHN of control group were significant higher than test groups (Table 4.8).

Table 4.8   Dunnet t- 2 sided test to compare mean VHN of control group and different mouthrinses

	(I) MOUTHRINSES	(J) MOUTH RINSES	Mean Difference (I-J)	Sig.
Dunnett t (2-sided)(a)	LISTERINE	control	-5.177(*)	.000
	ORAL B	control	-3.482(*)	.001
	MOUTHRINSES X	control	-3.767(*)	.000
	MOUTHRINSES Y	control	-4.865(*)	.000
	MOUTHRINSES Z	control	-4.197(*)	.000
	DISTILLED WATER	control	-2.902(*)	.006

Dependent Variable: VHN
Based on observed means.
* The mean difference is significant at the .05 level.
Dunnett t-tests treat one group as a control, and compare all other groups against it.

The data then, was analyzed using SPSS-General linear model-univariate analysis of variance for test between subject effects between groups. The results showed that composite, mouthrinses and composite*mouthrinses interaction were significant. The P-value for composite, mouthrinses and composite*mouthrinses interaction was less than 0.05 (Table 4.9). Levene's test was run for equality of variances and found a significant departure from equality (Table 4.10). Thus, Post-hoc test using Games-Howell for multiple comparisons between groups was chosen for this study.

Table 4.9 Tests between-subjects effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	16774.118(a)	27	621.264	25.021	.000
Intercept	1622513.026	1	1622513.026	65345.326	.000
COMPOSITE	14555.636	3	4851.879	195.405	.000
MOUTHRINSES	960.267	6	160.045	6.446	.000
COMPOSITE * MOUTHRINSES	1258.214	18	69.901	2.815	.000
Error	6257.116	252	24.830		
Total	1645544.260	280			
Corrected Total	23031.234	279			

a R Squared = .728 (Adjusted R Squared = .699)

Table 4.10   Levene's test of equality of error variances

Dependent Variable: VHN

F	df1	df2	Sig.
2.242	27	252	.001

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

Post-hoc Games-Howell test for mouthrinses showed that there were no significant difference between mean VHN of composites immersed in various mouthrinses. The result showed that types of mouthrinses may not be the major factor affecting the VHN.

The post-hoc Games-Howell test for multiple comparisons of different composites is presented in Table 4.11. The test showed that there was significance difference for each group except between Ceram•X Mono and Ceram•X Duo-enamel shade.

Table 4.11 Games-Howell-Multiple Comparisons of VHN in composites

(I) COMPOSITE	(J) COMPOSITE	Mean Difference (I-J)	Sig.
TPH SPECTRUM	FILTEK Z350	-19.039(*)	.000
	CERAM X•MONO	-5.560(*)	.000
	CERAM X•DUO	-3.544(*)	.000
FILTEK Z350	TPH SPECTRUM	19.039(*)	.000
	CERAM X•MONO	13.479(*)	.000
	CERAM X•DUO	15.494(*)	.000
CERAM•X MONO	TPH SPECTRUM	5.560(*)	.000
	FILTEK Z350	-13.479(*)	.000
	CERAM X•DUO	2.016	.233
CERAM•X DUO enamel shade	TPH SPECTRUM	3.544(*)	.000
	FILTEK Z350	-15.494(*)	.000
	CERAM X•MONO	-2.016	.233

Based on observed means.
* The mean difference is significant at the .05 level.

Although the VHN for Ceram•X Mono was not significantly different for all mouthrinses, the VHN for Ceram•X Mono is consistently low after immersion in experimental plant extract mouthrinses X, Y and Z as illustrated in the profile plot in the Figure 4.2. However, this trend was not observed in Ceram•X Duo-enamel shade group.
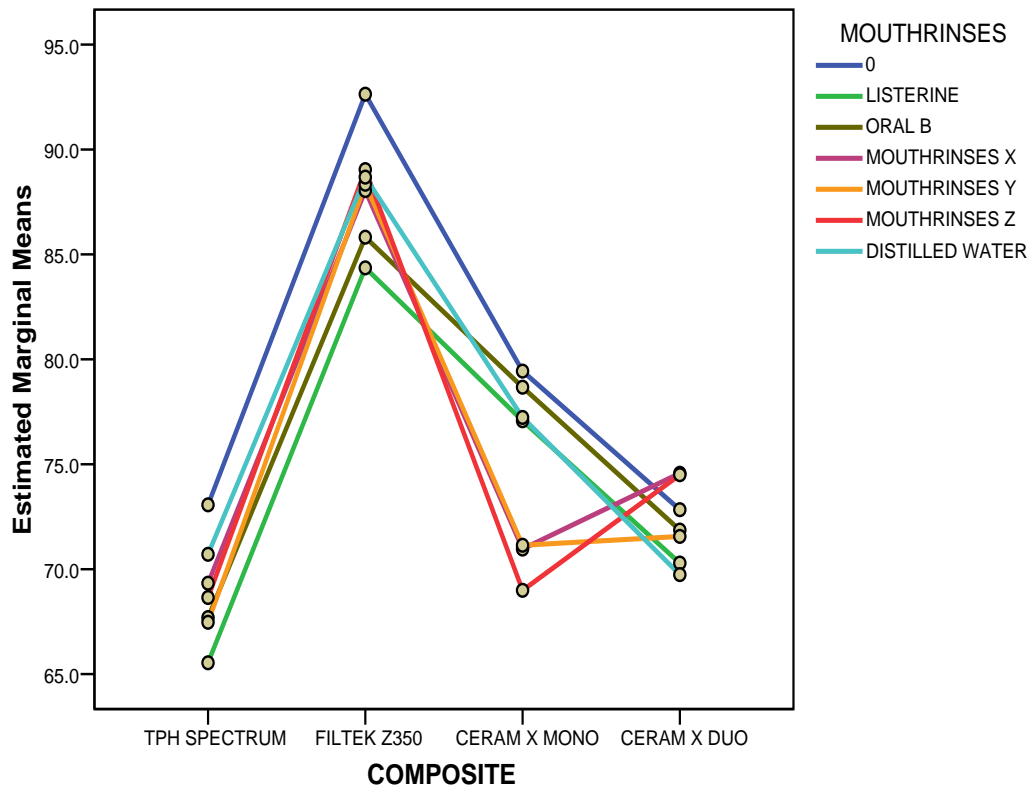
Figure 4.2   Profile plot of composites in different mouthrinses

4.3 Surface analysis

The 3D topography surface analysis of TPH Spectrum after immersion is shown in Figure 4.3. Specimens immersed in mouthrinses X had the lowest Ra (79.44nm) and specimens in distilled water had the highest Ra (280.8nm). Specimens immersed in mouthrinses Z for Filtek Z350 had the lowest Ra (45.65nm) and specimens in Listerine had the highest Ra (574.5nm) (Figure 4.4). For Ceram•X Mono, specimens in distilled water showed the lowest Ra (191.5nm) and specimens in mouthrinses Y had the highest Ra (316.8nm) (Figure 4.5). Specimens in mouthrinses Y for Ceram•X Duo-enamel shade showed the lowest Ra (62.54nm) and specimens in Oral B showed the highest Ra (304.3nm) (Figure 4.6)
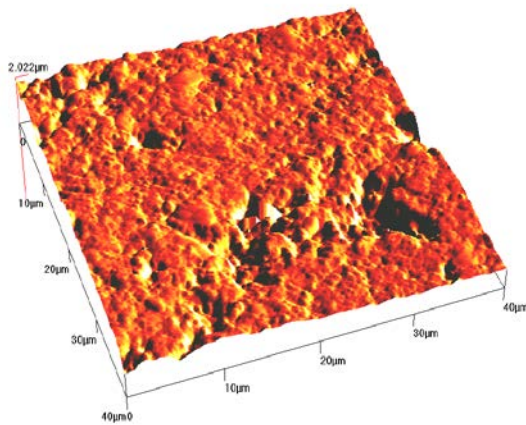
a- TPH Spectrum in Listerine

Ra= 151.7nm
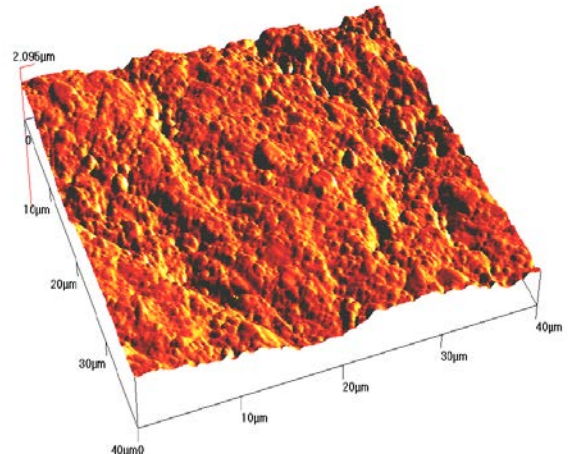
b- TPH Spectrum in Oral-B

Ra=255.8nm
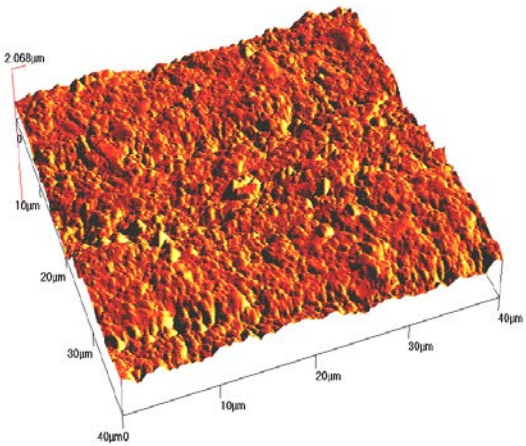
c- TPH Spectrum in distilled water

Ra=280.8nm
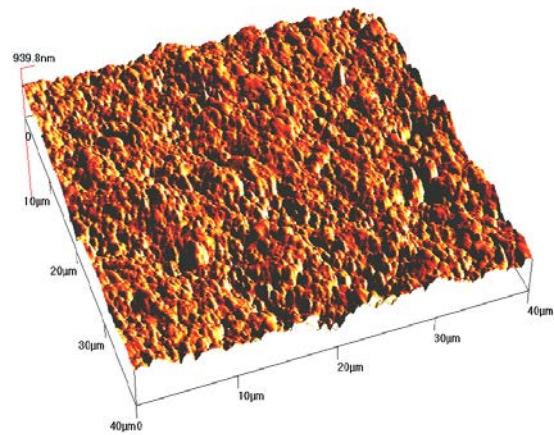
d- TPH Spectrum in Mouthrinses X

Ra= 79.44nm
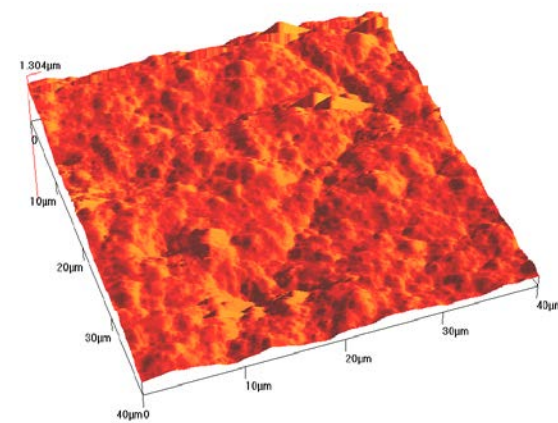
e- TPH Spectrum in Mouthrinses Y

Ra= 130.2nm
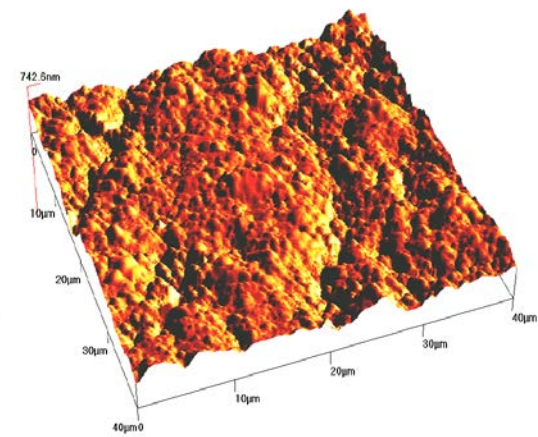
f- TPH Spectrum in Mouthrinses Z

Ra= 116.7nm

Figure 4.3   Surface analysis of TPH Spectrum after immersion in different mouthrinses
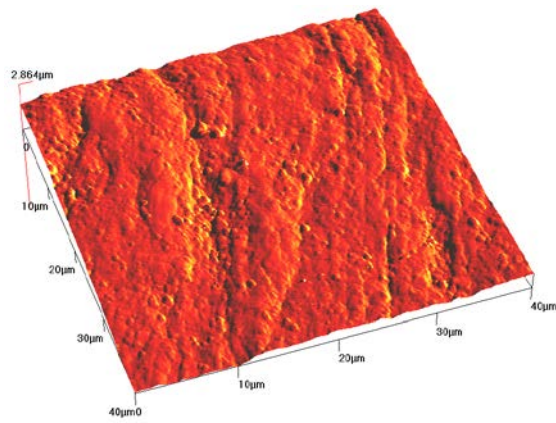
a- Filtek Z350 in Listerine

  Ra= 574.5nm
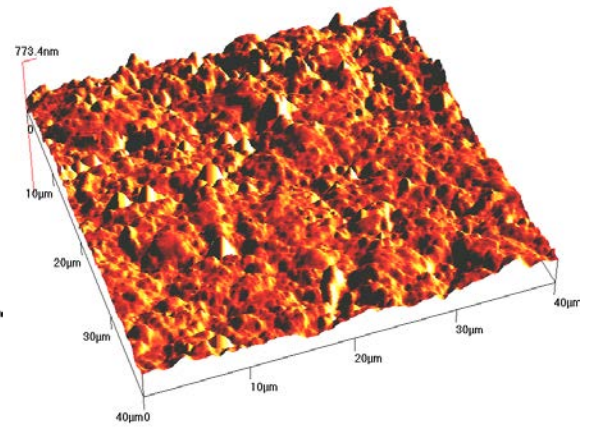
b- Filtek Z350 in Oral B

  Ra=283.3nm
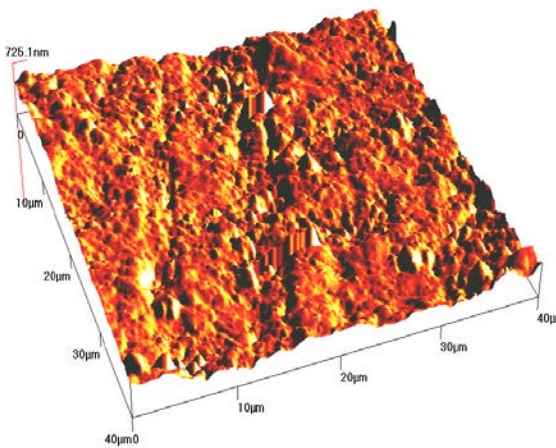
c- Filtek Z350 in distilled water

  Ra= 102.5nm
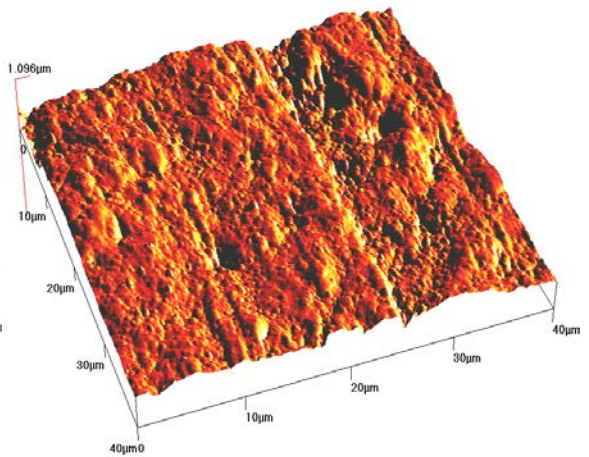
d- Filtek Z350 in Mouthrinses X

  Ra= 313.8nm
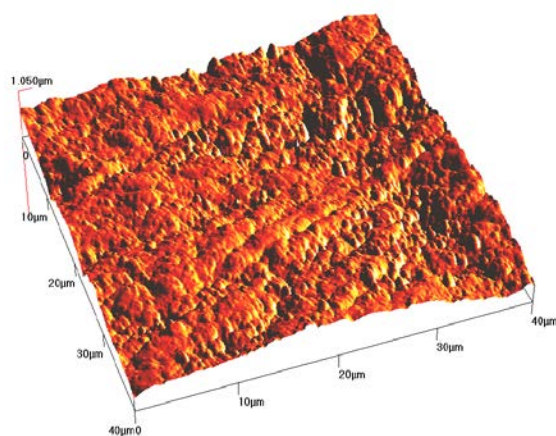
e- Filtek Z350 in Mouthrinses Y

  Ra- 316.8nm
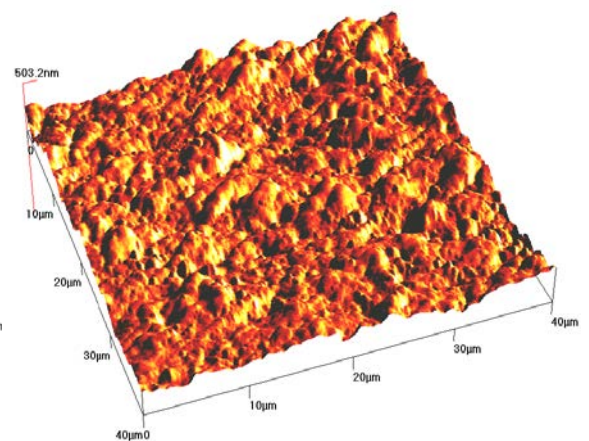
f- Filtek Z350 in Mouthrinses Z

  Ra= 45.65nm

Figure 4.4   Surface analysis of Filtek Z350 after immersion in various mouthrinses
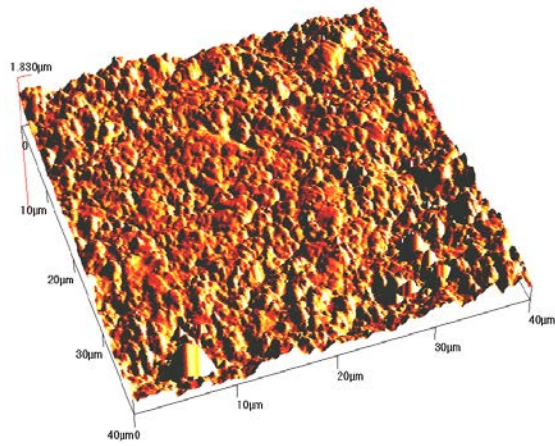
a- Ceram•X mono in Listerine

Ra= 236.0nm
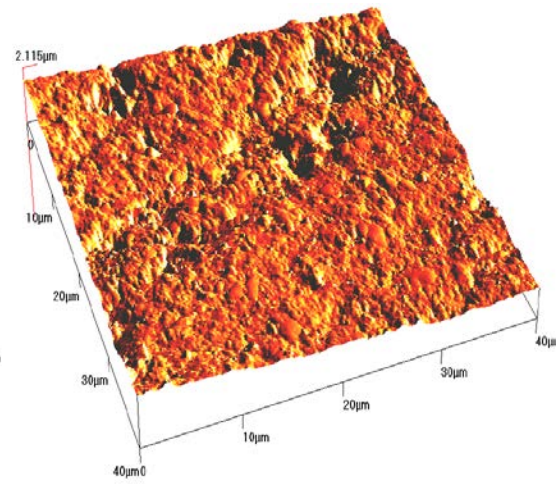
b- Ceram•X Mono in Oral B

Ra=200.8nm
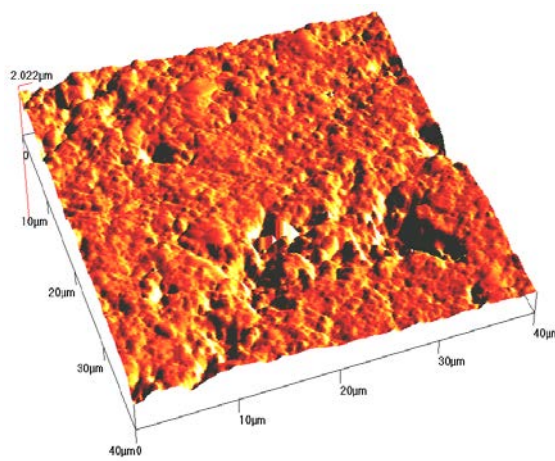
c- Ceram•X Mono in Distilled water

Ra= 191.5nm
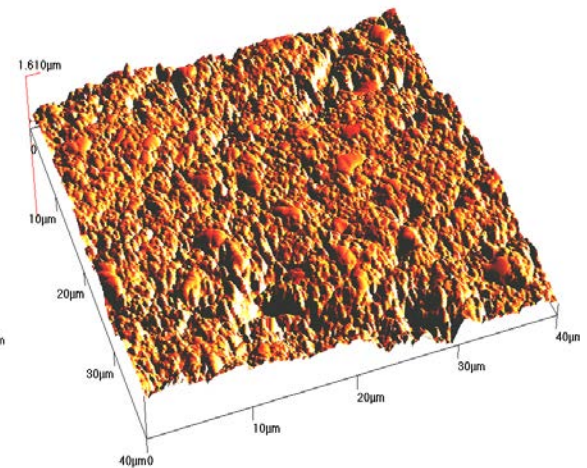
d- Ceram•X Mono in Mouthrinses X

Ra= 252.1 nm
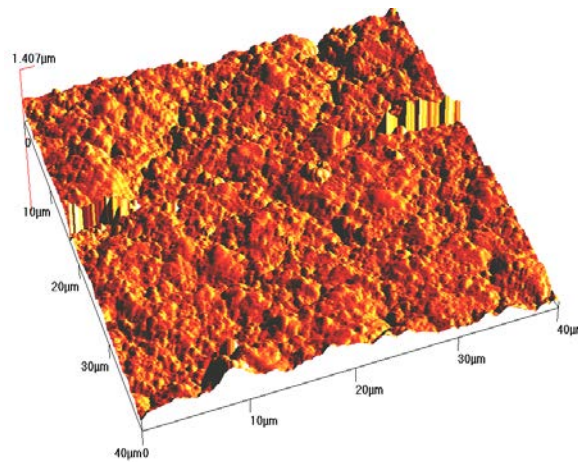
e- Ceram•X Mono in Mouthrinses Y

Ra= 316.8nm
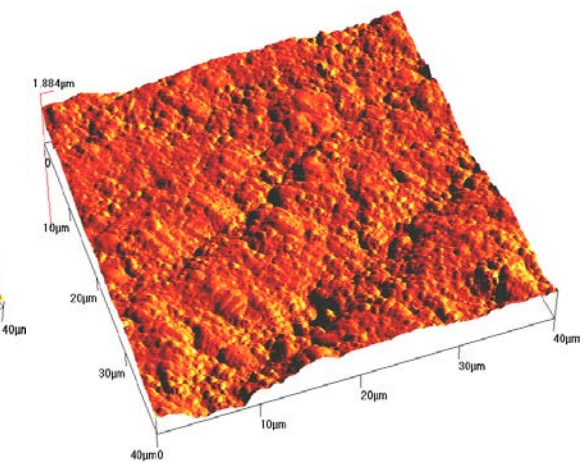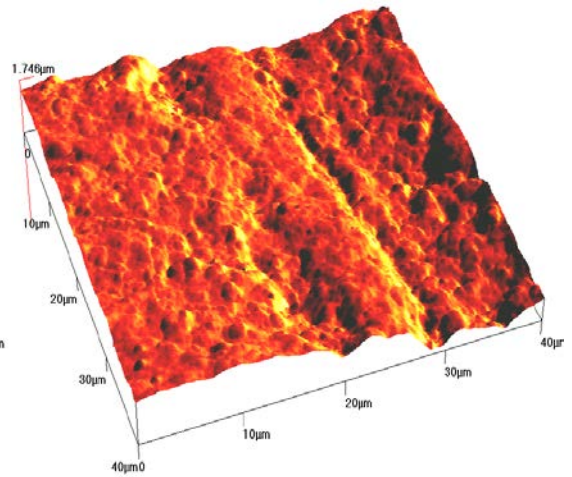
f- Ceram•X Mono in Mouthrinses Z

Ra=262.1nm

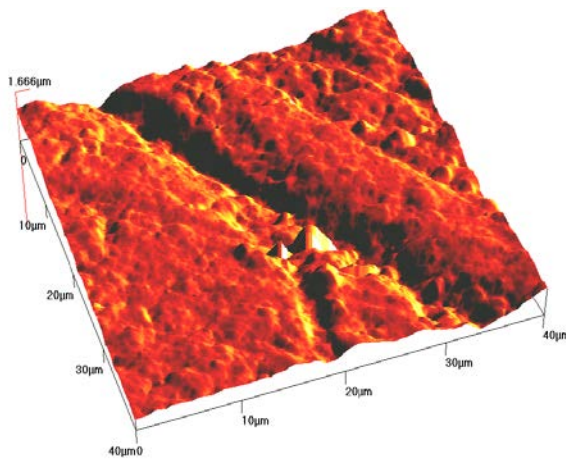Figure 4.5 Surface analysis of Ceram•X Mono after immersion in various mouthrinses
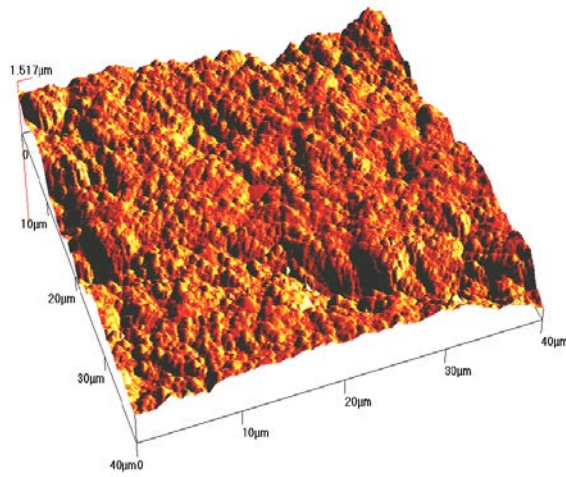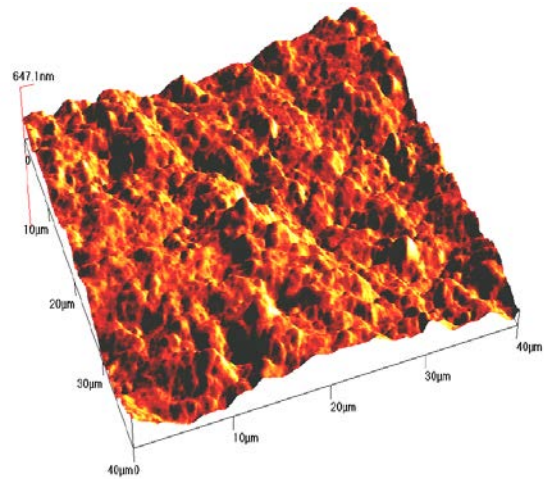
a- Ceram•X Duo in Listerine

Ra= 226.3nm

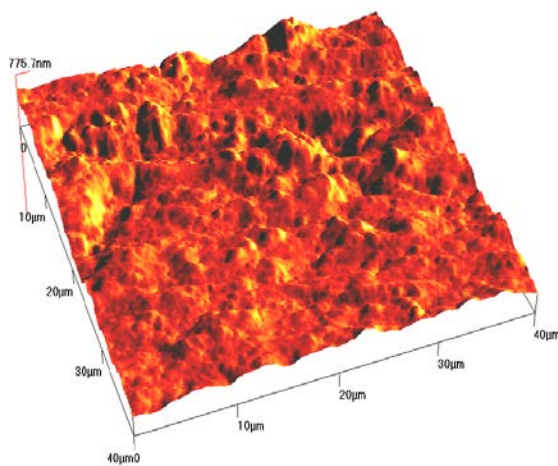b- Ceram•X Duo in Oral B

Ra=304.3nm

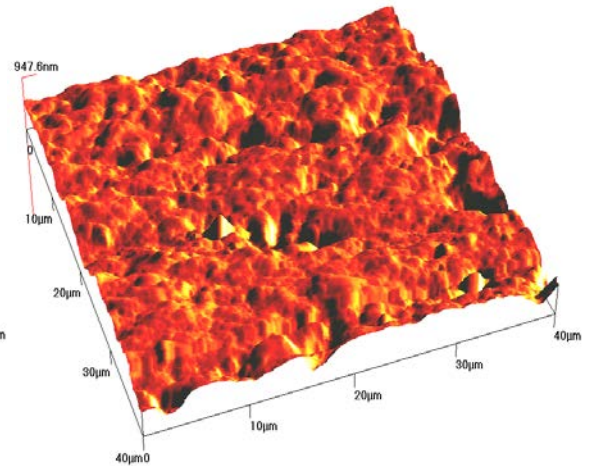c- Ceram•X Duo in distilled water

Ra=226.3nm

d- Ceram•X Duo in Mouthrinses X

Ra= 84.47nm

e- Ceram•X Duo in Mouthrinses Y

Ra= 62.54nm

f- Ceram•X Duo in Mouthrinses Z

Ra= 209.5nm

Figure 4.6 Surface analysis of Ceram•X Duo after immersion in various mouthrinses