CHAPTER 6

ASSESSMENT OF THE EFFECT OF FLUORIDE RELEASING MATERIALS IN HUMAN ENAMEL AND DENTIN USING PHYSICAL METHOD (EDS)

6.1. Introduction & Literature review

From the previous chapter, it was shown that there was some influence on the hardness of the tooth structure adjacent to the fluoride restorative materials. In terms of chemical constituents, the composition elements of enamel and dentin are Ca, P, S, Fe and others in addition to the organic part (C,N,O). With the method applied many factors that can influence the hardness were controlled except the amount of fluoride from the materials. Therefore the effect of the fluoride ion needed to be investigated. This study focused on the hardness change occurred adjacent to the restoration was from the change of inorganic chemical constituents of the tooth structure. This can be confirmed by quantifying fluoride content on the surface of enamel and dentin. The number of methodologies such as energy dispersive spectroscopy (EDS), Auger electron spectroscopy, atomic absorbtion spectroscopy can be applied to investigate metal ions in order to analyze elements (Postek,1980).

Energy dispersive spectroscopy (EDS) is one of analytical tool that permits a localization of chemical analysis with the micron range resolution. EDS was used as alternative method for the analysis of elements and quantitative measurement was represent in order to determine that the change of hardness is related to the element of the tooth structure. The X-ray can determine the amount of each element at the difference areas of specimen that is comparable. As one type of electron probe microanalysis, EDS detects the characteristic wavelengths of the x-ray spectrum. Qualitative and quantitative measurement can be obtained. The outcome is reported as relative concentration of the total elements.

Laufer et.al.(1981) investigated the fluoride concentration of dentin treated with fluoride, then using scanning electron microscopy and x-ray diffraction analysis. They found that CaF_2 could be identified in the APF (acidulated 0.1M H_3PO_4 2 % NaF solution) treated dentin specimen and it was found in the diffraction analysis that hydoxyapatite decreased while fluorapatite was formed. They suggested that an exchange of ions occurred at the surface region of the dentin. The changes of enamel and dentin surface hardness adjacent to the restoration were found in the previous experiments. If fluoride was the major factor of the surface hardness change, the different fluoride content should be detected in the different area. There are two methods that can be adopted to fluoride measurement. One is the chemical method and the other is physical method (Yamamoto et.al, 2000). The EDS is one of the physical method and nondestructive method that can be used to measure fluoride content in the different area. The objective of this study was to quantify fluoride content at the position where hardness measurements were performed.

6.2. Material & Method

The experimented enamel and dentin specimens which were utilized in the previous chapter were evaluated using EDS in a scanning electron microscope (SEM JSM-6400,JEOL Ltds,Tokyo,Japan). Analytical modes of EDS used in this study were:

1. Qualitative analysis mode. Identification the compositional elements was presented in the specimen at the measurement area. This mode provided basic information of the elements in the specimen in all area.
2. Quantitative analysis mode. This mode determined the concentration (wt%) of the elements at the spot area of 100 microns.

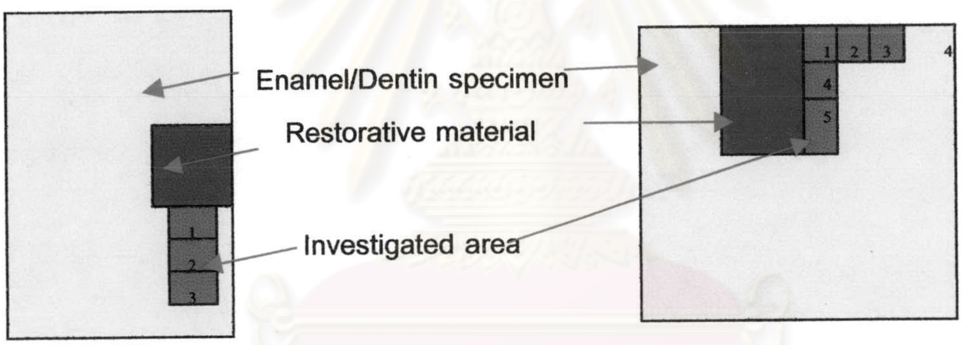
The investigated areas were the surface and the subsurface of the experimented specimens.

Surface

The area of 100x100 μm next to the interface of restorative material and another two areas of 100 μm from the previous area were investigated with two modes of EDS as shown in Figure 6.1.

Subsurface

Three areas of every 100 μm next to the restorative material and another two areas of every 100 μm from the first subsurface area were quantified with two modes of EDS as shown in Figure 6.2.



Surface

Subsurface

Figure 6.1. Schematic of the fluoride measurement on the surface specimens

Figure 6.2. Schematic of the fluoride measurement on the subsurface specimens

The quantitative analysis of fluoride in the definite area of each specimen was achieved. The average of the fluoride content in every detected specimens was calculated and presented as the trend of the hypothesis.

6.3. Results

The results of the fluoride content detected by EDS was divided into two groups.

6.3.1. Fluoride content in enamel specimens

6.3.1.1. Surface investigation

The enamel specimens quantified by EDS for each group of material was exhibited in the Figures 6.3. Fluoride content on the surface of negative group was the least and showed almost the same amount in all locations. In the positive group, fluoride content was found in the same amount in each location but the average amount of fluoride was much more than other groups. However, the resin modified glass ionomer cement and polyacid modified resin composite group showed the higher fluoride content on the area next to the restoration as shown in Figure 6.3.

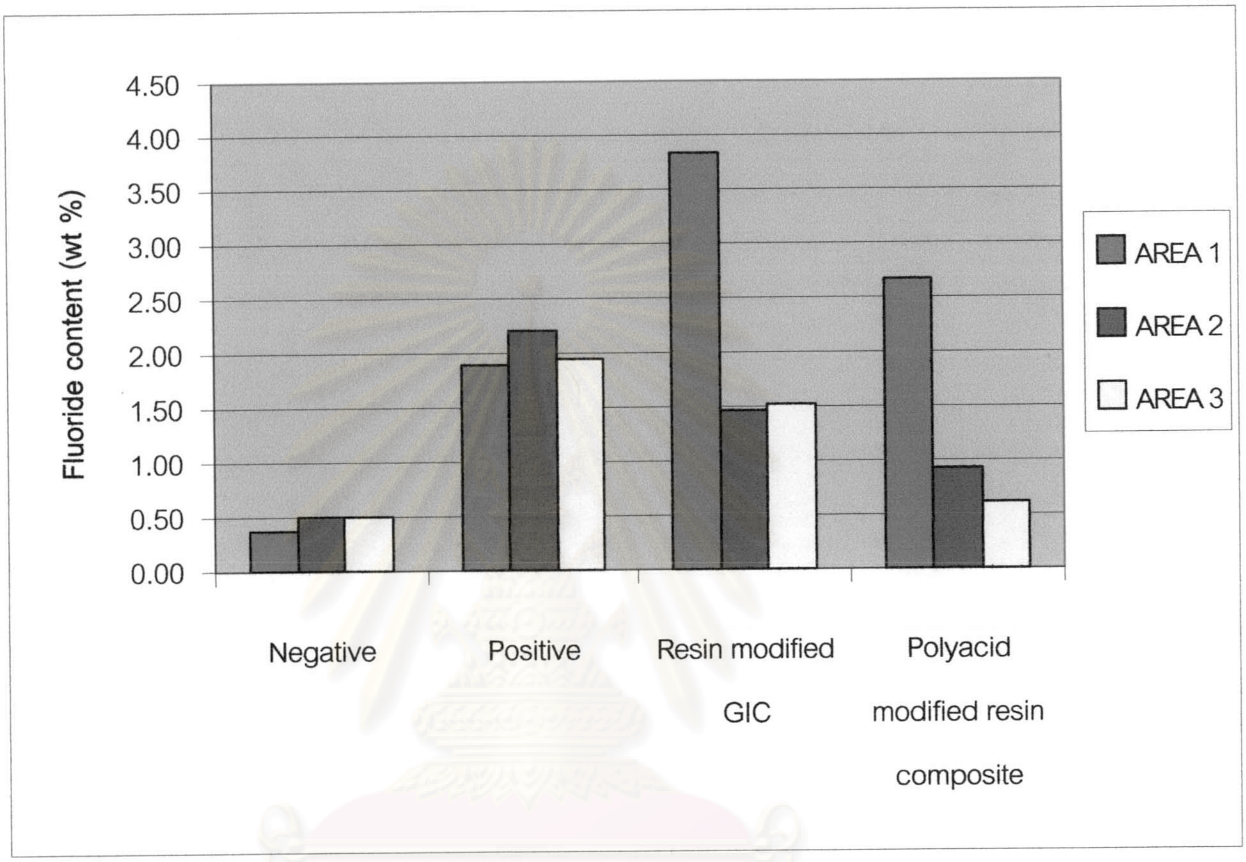


Figure 6.3. Bar graph showed the fluoride content of the surface enamel specimens on each location of all group studied.

6.3.1.2. Subsurface investigation

Subsurface fluoride contents of enamel specimens were quantified by EDS. The average of fluoride content in each group was exhibited in the Figure 6.4. Negative group found the least fluoride content at the same amount in each location. In the positive group there was the same amount of fluoride content in each location but the amount of fluoride was much more than other groups. However, the resin modified glass ionomer cement and polyacid modified resin composite group showed higher fluoride content next to the restoration than the other areas as shown in Figure 6.4. Even though the area no 4 was deeper but next to the restoration, the fluoride was found more than area no 2 and 3 which were far from the restoration.

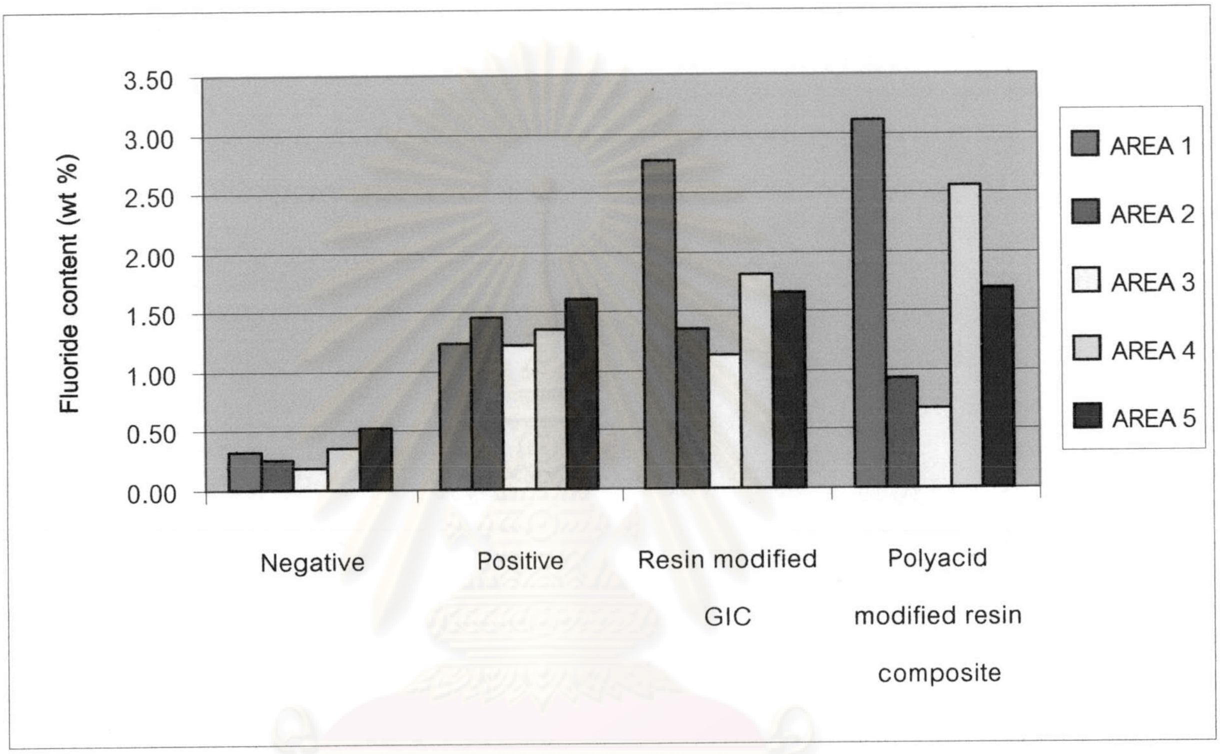


Figure 6.4. Bar graph showed the fluoride content of the subsurface enamel specimens on each location of all group studied

6.3.2. Fluoride content in dentn specimens

6.3.2.1. Surface investigation

The dentin specimens quantified by EDS and the average of fluoride in each group was exhibited in the Figure 6.5 and 6.6. Fluoride on the surface of negative group was the least and almost the same amount of fluoride in each location. Also in the positive group was the same amount of fluoride in each location but the amount of fluoride was much more than others. However, the resin modified glass ionomer cement and polyacid modified resin composite group showed that the higher fluoride next to the restoration as in Figure 6.5

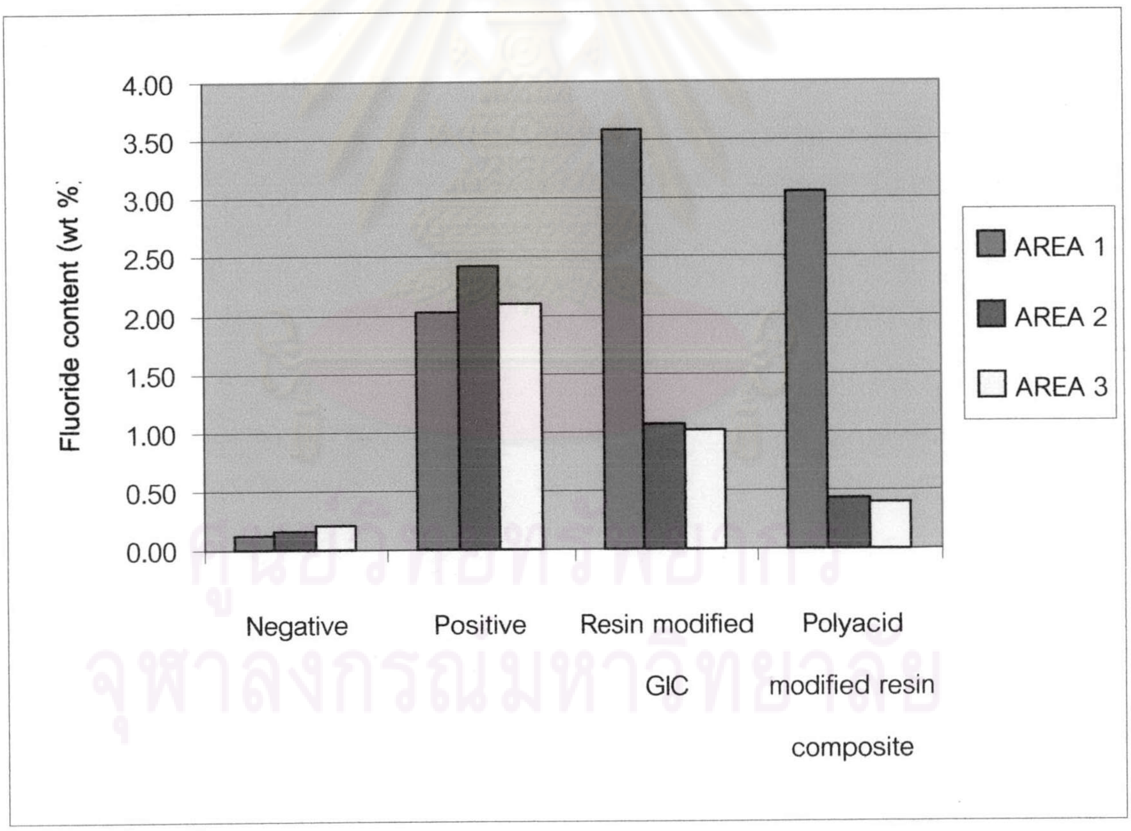


Figure 6.5. Bar graph showed the fluoride content of the surface dentin specimens on each location of all group studied

6.3.2.2. Subsurface investigation

The fluoride at the cross-section of dentin specimens was quantified by EDS. Then the average of fluoride in each group was exhibited in the Figure 6.5. Negative group found that fluoride was the least and almost the same amount of fluoride in each location. Also in the positive group was the same amount of fluoride in each location but the amount of fluoride was much more than others. However, the resin modified glass ionomer cement and polyacid modified resin composite group showed that the higher fluoride next to the restoration than the others area as in Figure 6.6. Even though the area no. 4 was deeper but next to the restoration, the fluoride was found more than area no. 2 and 3 which were far from the restoration.

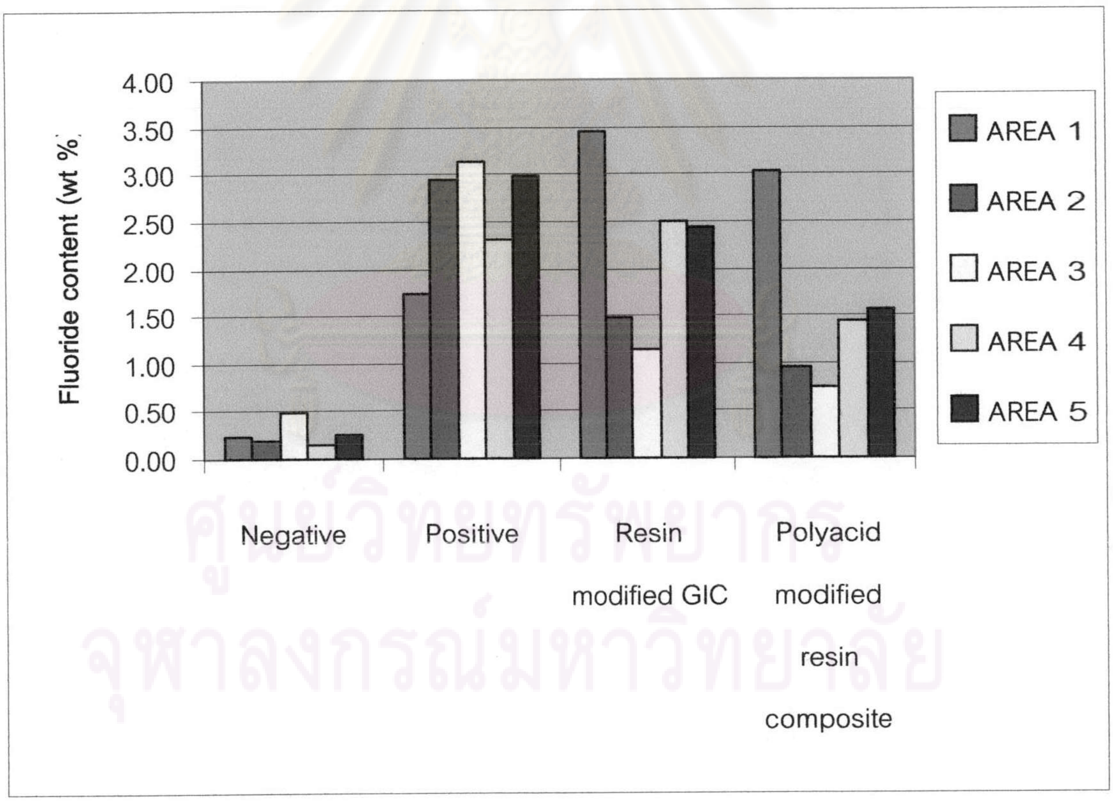


Figure 6.6. Bar graph showed the fluoride content of the subsurface dentin specimens on each location of all group studied

6.4. Discussion

In the present study, there were hardness changes of the surface and the subsurface of human enamel and dentin as a function of distance from the tooth material interface of the fluoride releasing materials. This chapter demonstrated the measurement of amount of the fluoride at the spot where the hardness measurement was made. The physical method that can be used was EDS. The x-ray measured the amount of specific element at difference areas of specimen. The outcome was relative concentration of the total constituents and this was the limitation of EDS. However, the quantitative data of elements were achieve by comparing the x-ray intensities of these samples to the standards, because the mass concentration (wt%) of the element is related to the x-ray intensity.

The result of the study showed that the areas within 100 microns from the interface and tooth surface had the highest value of fluoride content compared to other areas in resin modified glass ionomer cement and polyacid modified resin composite groups. The high fluoride content was found at the locations where the tooth hardness was high (in chapter 4) and penetration depth was less (in chapter 5). This showed that fluoride content would give higher hardness value or less penetration ability when subjected to the same force. This phenomena could be explained that fluoride in a low viscosity resin penetrated into the tooth with the flow of the resin or liquid through the dentinal tubule (ten Cate, Damen and Buiji 1998). Then the fluoride can diffuse through the wall of the tubule. If fluoride had an effect on the microhardness change as the hypothesis in the previous chapter, the difference amount of fluoride could be detected.

The big difference in the results was found in the groups of negative and positive control where the same material was used. Though the two groups were subjected to the same method but the positive group where the higher concentration of fluoride was applied showed high amount of fluoride. This confirmed that the fluoride could penetrate into tooth structure and at the same time reduce the hardness drop due to the demineralization solution. If the tooth structure was not applied with fluoride as in negative group, the demineralization process could easily progress well and thus reduce the hardness. This confirmed the ability of fluoride in the reduction of demineralization process.

The surface microhardness was one of the index of the tooth structure and can be related to caries formation. Tal et al (1976) stated that fluoride may be organically bound in tissue fluids, enamel, dentin and bone and Laufer et.al (1981) found fluoride is deposited in dentin, following treatment with solutions of high fluoride concentration. Therefore, fluoride could be transferred to tooth structure in which more fluoride content was found in accordance to the high value of hardness measured by both indentation methods.