CHAPTER 2

Literature review

2.1 Literature survey of prophylaxis paste

In 1993, Baffelli, et al. investigated in the topic of "water-free prophylactic paste containing perlite". A dental care and cleaning composition in prophylactic paste contains polishing body at least about 40% by weight of perlite. Furthermore propylene glycol, or 1, 2-propanediol and at least one wetting agent for the perlite particles are also included, the said composition being substantially free from water. An average size of perlite is between about 20 and 40 microns. The composition comprising at least about 40% by weight of propylene glycol, futhermore some wetting agents and at least one stabilizer for the combined cleaning and polishing body. The stabilizer comprises a hydrophobic, finely divided silicic acid in amounts of from 2 to 4% by weight giving thixotropy to the composition. The wetting agent comprises a dialkylsulfosuccinate and another wetting agent, namely a polyoxyalkylene dimethylsiloxane. The composition comprises at least one hydroxyalkyl cellulose which is soluble in the propylene glycol under gel formation. Moreover, the composition is also comprised of pigments, fluorine compounds, sweetening agents, flavoring agent and mixtures thereof.

The composition of water-free prophylactic paste has a composition in the following range, in percent by weight:

Perlite, average particle size of 20 to 45 microns	40-45
Propylene glycol	40-45
Hydroxypropyl cellulose	0.4-0.5
Dioctylsulfosuccinate	1-3
Polyoxyethylene dimethylsiloxane	0.5-1
Sweetening agent, pigment, flavoing agent fluorine source, bactericidal agent	

The chemical composition of perlite contains SiO_2 72.1-74.2%, Al_2O_3 12.3-13.5%, K_2O 3.8-5.0%, Fe_2O_3 0.5-1.8%, CaO 0.45-1.5%, MgO 0.03-0.5%, TiO_2 up to 0.1%, Na_2O 3-4.6%, and water 2.8-4.0%. These compositions are varying with the material sources.

The wetting of the perlite by prophylene glycol is achieved by the addition of at least one dispersing agent which displays its effectivity in a water-free phase and which thus guarantees the wetting of the hydrophobic perlite surfaces. It is preferred to use a dioctyl sulfosuccinate " REWOPOL SBDO 70" in the compositions, as it also has a desired effect against plaque and bacteria.

A stabilizer can be hydrophobic fumed silica such as "AEROSIL R 974" of the company (DEGUSSA, Germany). This substance confers the paste the desired thixotropy in the anhydrous medium. The paste containing this additive behaves nearly like solids and can only be liquefied by vigorous shaking. This property is important to give a strong adherence of the paste to the cleaning tool, namely a rotating rubber disk or a brush.

As to the wetting of the Aerosil, the wetting and the stability of the paste is improved by the addition of a wetting controlling agent, for example a nonionic product (SILWET L 7600). Finally, it is advantage to control the viscosity of the composition. The purpose is achieved by the addition of a thickening and gelating agent soluble in the prophylene glycol: examples are cellulosic derivatives such as hydroxypropyl cellulose (KLUCEL HF).

Preferred dental care and cleaning compositions according to the invention are generally composed of the following ranges:

Perlite, average particle size 20 to 40 microns	40-45%
Propylene glycol	40-45%
"KLUCEL HF"	0.4-0.5%
"AEROSIL R 974"	2-5%
"REWOPOL SBCO 70"	1-3%
"SILWET L 7600"	0.5-1%

In addition, as far as desired, pigments, sweetening agents, fluorine compounds, and aromatic oils and flavoring agents can be added.

The abrasive properties of the cleaning and polishing agents defined above are REA value: 4.4 and RDA value: 24. The abrasion values are thus much smaller than those of known pastes. It has been found that the compositions of the invention allow the cleaning and the polishing of a tooth in only about 10 s. The surface of the enamel and of the dentine is absolutely free from corrugations, striations and scratches.

European patent application no. EP-A2-0,268,763 discloses a dental composition where in the cleaning body is a mixture of synthetic precipitated silica and perlite. This composition contains aqueous glycerol as a liquid phase. Another patent, FR-A2, 158,217, describes the products contain abrasive agent, polishing agent and thickening agent, and abrasive agents comprise finely divided silicates, particularly aluminum silicate of a defined composition and having a particle size comprised between 5 and 15 microns or from 10 to 30 microns. As polishing agent, precipitated silicic acid is used, and the thickening agent is fumed silica (Aerosil) *(11)*.

In 2002, Million , Lori A. investigated in the topic of "prophylaxis paste". A prophylaxis paste for dental hygiene use comprising a carrier suitable for use as a dentifrice in combination with about 1.03-7.27% by weight roxite particles having an average particle size less than 5 microns. An additional constituent is silicon dioxide particles (Zeodent 113) an average particle size of between about 8 and about 16 microns. Zeodent 165, an average particle size between 8-13 microns is present in

prophylaxis paste in the amount of about 20.78-28.69% by weight and it an average particle size between 10-16 microns the amount is about 2.91-6.23% by weight. Furthermore, A polyol is present in prophylaxis paste. Polyol is selected from the group consisting of sorbitol, glycerol and maltitol. Maltitol is present in the amount of 4.16-12.46% by weight. Sorbitol is present in the amount of 4.20-12.46% by weight. Vegetable gum (Carageenan) is present in the amount of 2.07-6.23% by weight. The paste contains a therapeutically effective amount of a bacteriostat (Tricosan) between about 0.30-0.50% by weight. In addition to the above ingredients, sodium saccharide, flavors, colors and orther additives are added in amounts known in the art *(12)*.

In 2003, Kilcher,et al investigated the dental care composition. A prophylaxis contains (a) a cleaning body comprising a major proportion of plate shaped of perlite particles, (b) 20-80% by weight of at least one polyethylene glycol nonionic surfactant and, (c) at least one emulsifying agent, the combined amounts of cleaning body and of surfactant being at least 30% by weight of the dental care composition, the proportion of emulsifying agent being comprised between 0 and 20% by weight of the dental care composition. The dental care composition containing from 10 to 80% by weight of plate shaped perlite, from 40 to 50 % by weight of polyethylene glycol, as surfactant, from 1 to 10 by weight of emulsifying agent.

His suggested composition can be concluded as follows:

A dental care composition according to the invention comprises at least the following characteristic components:

Perlite (Expanded)	10-80% by weight
Macrogol	20-80% by weight
Emulsifyer or emulsifyer mixture	0-20% by weight
Additives and active substances	0-20% by weight
Fillers	0-70% by weight

The perlite which can be used has an average particle diameter of about 30 micron, 99% thereof being present within the size range of from 1 to 200 microns. For example, a typical composition of the paste according to the invention is as the following Table 2.1*(13)*.

Table 2.1 A typical composition of the paste *(13)*

Component	Amount, % wt
Perlite	45
Polyethylene glycal 400 (Macrogol)	43
Emulsifyer	3
Cetyl alcohol	3
Flavoring agent	2
Titanium dioxide (Pigment)	2
Coloring agent (Red iron oxide)	1.7
Sweetening agent (Aspartame .RTM.)	1
Sodium fluoride	0.3

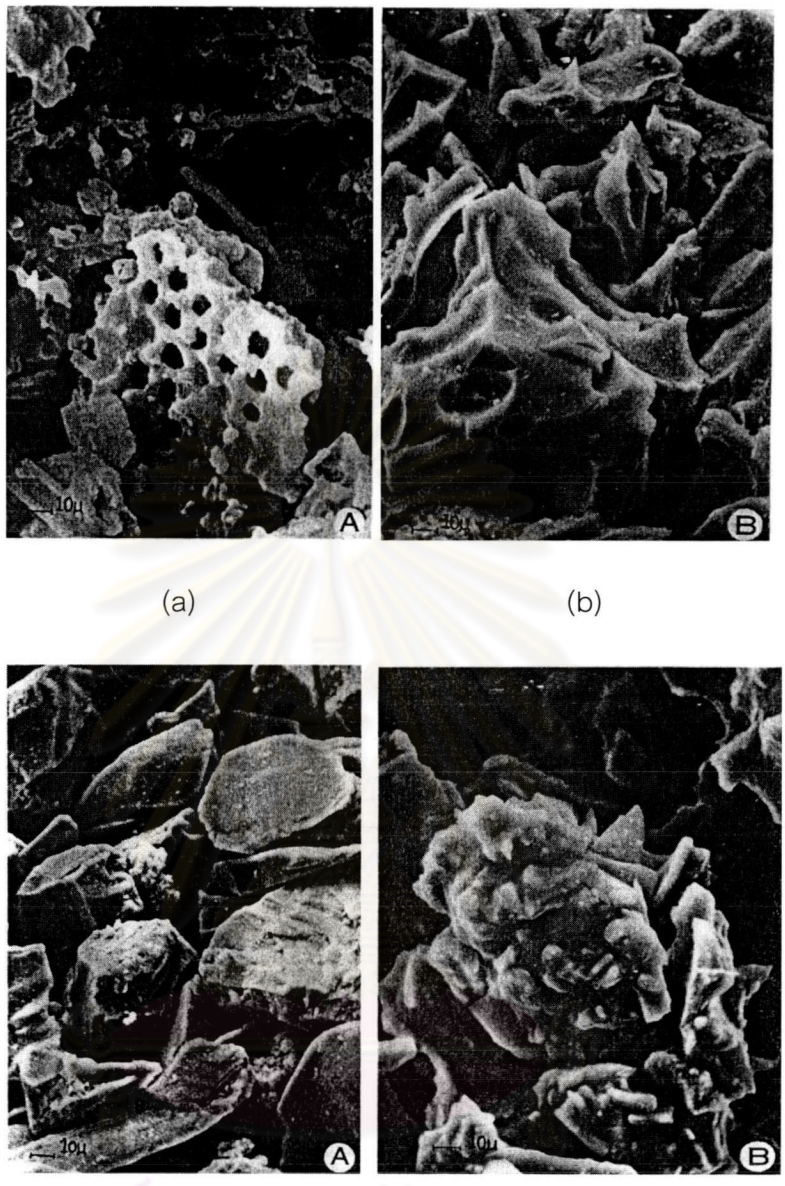
In 2004, Silber, Gert; et al. purposed a prophylaxis paste contains 3% flavoring agent, 2% cetyl alcohol, 3% emulsifier (Emulgin R 040, Henkel, Germany), 3% coloring agent (Red iron oxide), 1.7% sodium fluoride, 2.8% glassflakes (RCF-160), 40% polyethylene glycol (Macrogol 400), 4.3% sweetening agent (Aspartame .RTM.), 1% titanium dioxide, and 2% gel forming agent (Tego carbomer 141,1.5 goldschmidt AG, Germany) *(14)*.

In 1974, Eric B. Brooks, James P. Voigt investigated in the topic of "Particle configuration of prophylaxis pastes as observed by scanning electron microscopy". To gather preliminary information about the structural nature of prophylaxis material particles at the microscopic level, for future clinical evaluation of prophy materials methods. Samples of prophylaxis preparations were divided into two groups:

1. Preparations in powder form
2. Preparations in paste form

Using the scanning electron microscope (SEM), prophylaxis material particles could be identified and separated into distinct groups on the basis of topographical appearances. They were arbitrarily named according to their empirical appearances:

1. Favosed: honeycomb-like sheets.
2. Fragmented: particles showing total irregularity in shape as though fractured off a larger particle.
3. Formed: convex surface particles appearing boulder-like.
4. Conglomerate: particles with glazed spike-like projections resembling peanut brittle *(15)*.



(a) (b)

(c) (d)

Fig 2.1 SEM micrographs of Particle configuration of prophylaxis pastes

(a) Favosed particles showing characteristic honeycomb-like sheets. x600

(b) Fragmented particles showing ragged, asymmetrical particles. X600

(c) Formed particles showing convex, smooth surface, boulder-like particles.X600

(d) Conglomerate particles showing glazed spike-like projections similar to peanut brittle. X600 *(15)*

In 1993, Felix Lutz, Beatrice Sener, Thomas Imfeld, Fred Barbakow, Peter Schüpbach investigated in the topic of "Self-adjusing abrasiveness: A new technology for prophylaxis paste". The purpose of this study was threefold: first; to examine the micromorphology and characteristics of perlite; second, to evaluate the polishing properties and the surface glosses on both enamel and dentin by an experimental prophylaxis paste that contains perlite; and third, to compare these properties to those of a standard prophylaxis paste, a positive control (Flour of pumice), a negative control (Water), and a polishing paste containing silicon and aluminum dioxide.

The mean particle size and the size distribution of the perlite abrasive were evaluated in the raw material, in the abrasive extracted from unused portions of the prophylaxis paste, and in the abrasive from used portions of the paste, ie, after a 5 minute prophylaxis on enamel with a rubber cup at 3,600 rpm and a load of 1.41 N.

The morphology of the perlite abrasives in their natural form, from the used prophylaxis paste, and from portion of the prophylaxis paste after 30, 60, 120, 240, and 300 second prophylaxes on enamel was investigated in a scanning electron microscope.

The polishing property and induced surface roughness were assessed on 100 enamel and 100 dentin specimens prepared from freshly extracted human premolars. Their surfaces had been flattened by wet grinding using water-resistant silicon carbide paper up to 2,400 grit. Each enamel and dentin specimens were polished for 5, 15, 30, 60, 90, and 120 seconds with either rubber cup or a nylon brush and one of the tested abrasives in a slow-speed contra-angle handpiece at 3,600 rpm and a load of 1.96±0.21N. During these treatments, fresh portions of the tested pastes were picked up every 15 seconds.

From the experiment, the main chemical components of the perlite-containing prophylaxis paste were perlite (about 50%) consisting of SiO_2 75%, Al_2O_3 11.5%, K_2O 5%, Fe_2O_3 2%, CaO 1%, and Na_2O 5% with trace of MgO. Furthermore the perlite-containing prophylaxis paste contained CaF_2 (1,500 ppmF-), an organic phase

45%, and filler 3%. The volume median diameter of particles was 63.59 micron for perlite raw material, 14.60 micron for the abrasive harvested from the unused prophylaxis paste, and 8.78 for the abrasive harvested from the paste after a 5 minute prophylaxis on enamel.

Conclusion, perlite, a natural abrasive with flat, sheetlike particles has both cleaning and polishing properties. The mean particle size, the size distribution, and the morphology of perlite from the unused and the used perlite-containing prophylaxis paste confirm the claims that the abrasive can partly disintegrate during incorporation into the paste and that it further break down and get blunt during clinical use on enamel and dentin. A change of the orientation of the abrasive particles to lie more parallel to the tooth surface after the first 5 to 10 seconds of a prophylaxis may further decreases the cleaning ability in favor of the polishing power. Furthermore, the perlite-containing prophylaxis paste produces no undesired optically or chemically induced luster and thus does not misleadingly disguise the true morphology of the treated surfaces. On dentin, as with all other abrasives tested, although not significantly with treatment times of less than or equal to 15 seconds *(4)*.

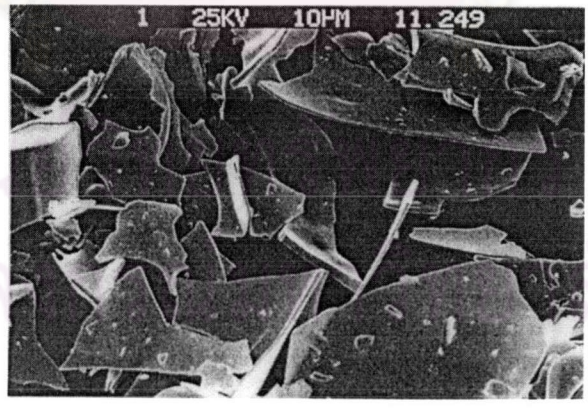


Fig 2.2 Scanning electron micrograph of perlite raw material. (Original magnification X 2,500) *(4)*

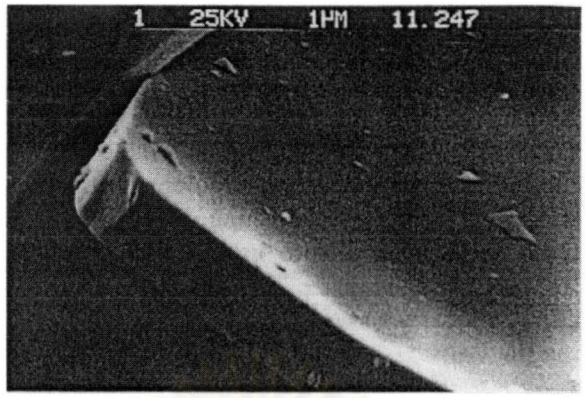


Fig 2.3 Scanning electron micrograph of perlite raw material. The cutting edges of the abrasive are sharp. (Original magnification X 25,200) *(4)*

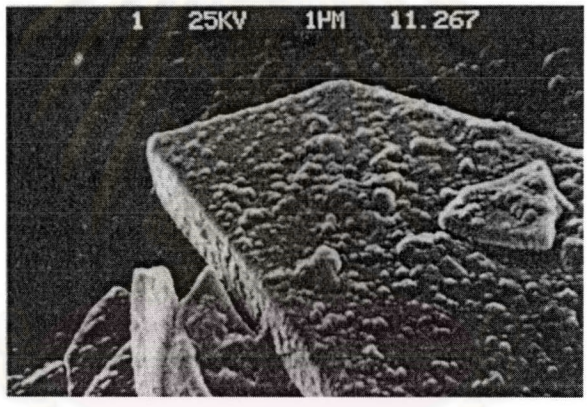


Fig 2.4 Scanning electron micrograph of perlite harvested from the freshly manufactured perlite-containing prophylaxis paste. The cutting edges of the abrasive are slightly blunted. (Original magnification X 36,000) *(4)*

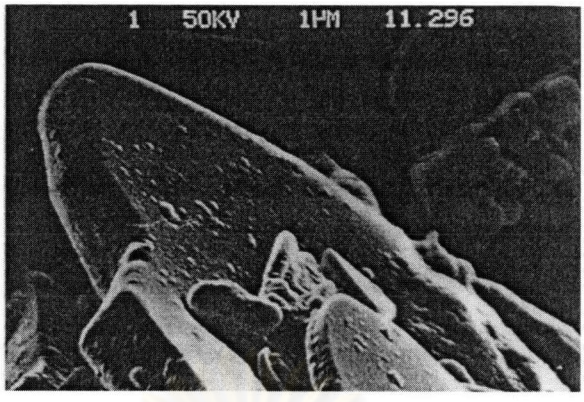


Fig 2.5 Scanning electron micrograph of perlite harvested from the freshly manufactured perlite-containing prophylaxis paste after 5 minute prophylaxis on enamel (in vitro) using rubber cup at 3,600 rpm and a load of 1.41 N. the abrasive has been blunted by the extensive use on enamel. (Original magnification X 32,400) *(4)*

In 1993, Felix Lutz, Beatrice Sener, Thomas Imfeld, Fred Barbakow, Peter Schüpbach also investigated in the topic of "Comparison of the efficacy of prophylaxis pastes with conventional abrasives or a new self-adjusting abrasive". They studied about the relative dentin abrasion (RDA), relative enamel abrasion (REA), the cleaning ability, and the polishing power of the perlite-containing prophylaxis paste and to compare the results with those of popular prophylaxis pastes *(16)*. The RDA and REA values of the pastes were evaluated by the radiotracer method on human dentin and enamel in accordance with American dental assosiation (ADA) specifications (Oral Health Reserch Institute, Indiana university). The dentin and enamel specimens, self-rotating at 20 rpm, were given a 30 second prophylaxis using rubber cups (RA Rubber Polishing Cups, Dentaires SA) or brushes with nylon bristles (Bürstchen OC, Orodent AG) at a load of 2.45 N and a speed of 1,800 rpm *(17,18)*.

Table 2.2 Materials used in previous report *(19)*

Cleaning and polishing media	Batch No.	Abrasive	Volume median diameter,size range of particles (μm)	Manufacturer
Control				
H_2O	Tap water, F^-&Cl^- free			
Flour of pumice	4405/1090	Flour of pumice	16.1, 0.9 * -73.0	Ammann
Prophylaxis paste				
CCS 250	8904250	Flour of pumice	26.4, 0.9-103.0	Clean chemical
Cleanic	111-925011	Perlite	13.5, 0.9-87.0	Hawe Neos
Détartrine Z	U4294	SiO_2 Zirconium-silicate	9.8, 0.9-73.0	Septodont
Nupro Coarse	Mint 801112 Lot OA 1805	Flour of pumice	28.6, 0.9-87.0	Dentsply
Zircate	060590	Zirconium-silicate	21.2, 0.9-103.0	Caulk
Polishing paste				
CCS 40	8904281	SiO_2, Al_2O_3	3.2, 0.9-15.0	Clean chemical

* Sympatec Helos particlesize analysis, lower measuring limit

Ten teeth each were used as dentin and enamel specimens. They were initially stained in a cola beverage that was continuously agitated at 37°C for 3 days. Ten operators were assigned to clean the specimens with the tested abrasives and rubber cups and nylon brushes, at a load of 1.96 ± 0.25 N and a speed of 3,600 rpm without water. The cleaning ability was expressed as the number of stain free square millimeters achieved within 30 second. The ranking was based on the mean and significant pairwise differences, traced by using Mann-Whitney U statistics. The surface roughness (Ra) scores were obtaining after 30 second. A prophylaxis paste index (PPI) is calculated by measuring the cleaning ability, the RDA or the REA value, and the surface roughness induced on dentin or enamel.

$$PPI_{dentin} = \frac{mm^2 \text{ freed from stain within 30 seconds} \times 10}{RDA \times Ra \text{ (30 seconds reading)}}$$

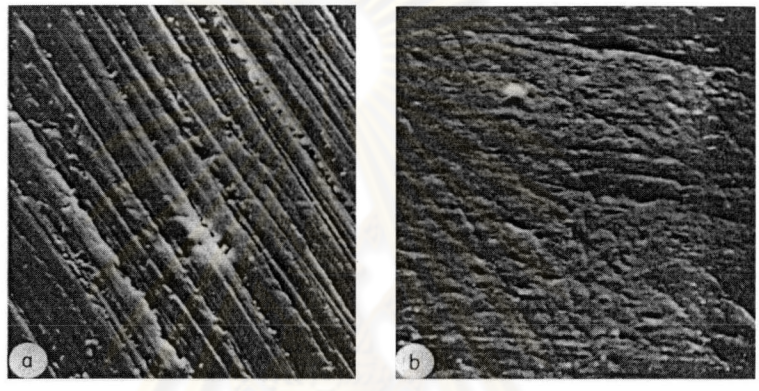
$$PPI_{enamel} = \frac{mm^2 \text{ freed from stain within 30 seconds} \times 10}{REA \times Ra \text{ (30 seconds reading)}}$$

The PPI thus assessed the ability of a prophylaxis paste to clean tooth surfaces, abrade as little dental material as possible, and yet obtain the smoothest possible surface.

The conclusion of this topic was the prophylaxis paste Cleanic, which contains the abrasive perlite, had a superior PPI on both dentin and enamel when used with rubber cups or with nylon brushes. PPI on enamel by using rubber cup and nylon brush are 309.6, 234.9 in order. PPI on dentin by using rubber cup and nylon brush were 41.3, 48.0 in order. This was due to its combination of low RDA and REA scores, high cleaning ability, and low Ra values *(16)*.

In 1985, E.S. Duke, R.W. Phillips and R. Blumershine investigeted the effect of various agents in cleaning cut dentin. Human extracted mandibular molars, stored in distilled water, were used. The flushing of water for 10 second was used as a

control procedure with the other technics. For example, the cleaning procedure of slurry of flour of pumice was applied with a rubber cup on a slow-speed handpiece and a representative prophy paste, Prevodontic (Mynol, Norristown, Pennsylvania), on rubber cup with slow speed. Following the cleaning procedures, the pumice wash and prophy paste appeared to remove most of the smeared layer. With the prophy paste, the surface was somewhat smoother and localized areas of dentinal tubules could be identified *(20)*.

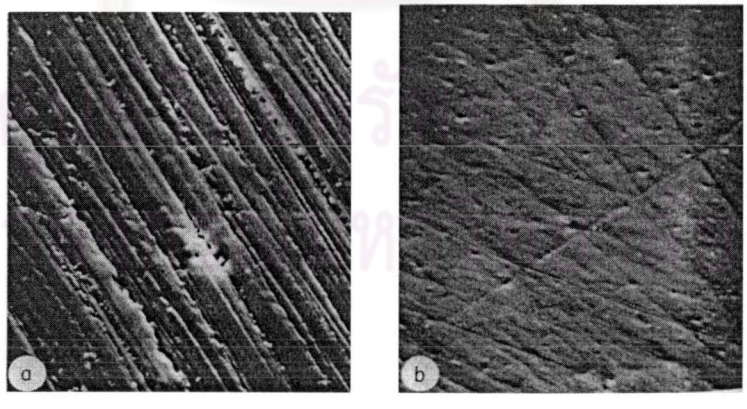


(a) (b)

Fig 2.6 SEM micrographs of dentin surface polished with pumice *(20)*

(a) Control

(b) Slurry of pumice applied with a rubber cup, x 800.



(a) (b)

Fig 2.7 SEM micrographs of dentin surface polished with Prevodontic prophy paste *(20)*

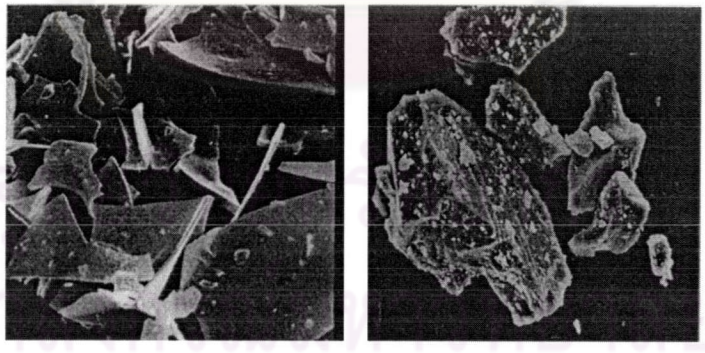
(a) Control

(b) Prevodontic prophy paste applied with a rubber cup, x800

In 2002, Felix Lutz and Thomus Imfeld investigated in topic "Advances in abrasive technology-prophylaxis pastes". An in vitro study. An experimental prophylaxis paste containing perlite, a standard prophylaxis paste containing flour of pumice, and a polishing paste containing silicon and aluminum dioxide were analyzed in regard to relative dentin abrasion (RDA), relative enamel abrasion (REA), cleaning ability, and polishing property/surface roughening.

The relative abrasion values, assessed by the radiotracer method, the cleaned area in mm^2 after 30 seconds. Cleaning ability, the perlite based prophylaxis paste consistently showed an exellent cleaning ability equal or superior to the pumice prophylaxis paste. There was generally no correlation between the cleaning ability and the induced surface roughness. However, the perlite prophylaxis paste yielded the best cleaning effects with the smoothest surfaces.

The PPIs of the pumice prophylaxis paste have similar performance patterns. In contrast, the perlite prophylaxis paste performed best on dentin and enamel and both with rubber cup and nylon bristle brush *(21)*.

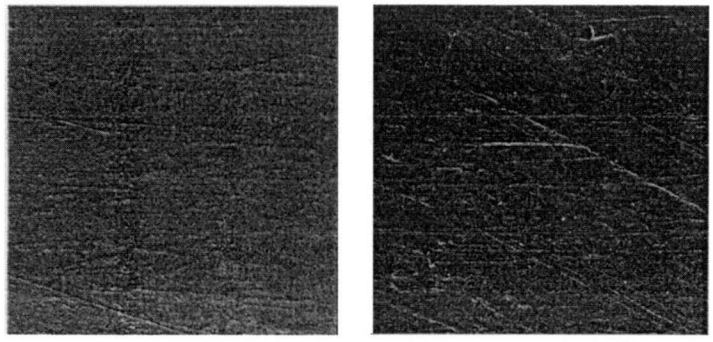


(a) (b)

Fig 2.8 SEM micrographs of raw materials in prophylaxis paste *(21)*

(a) Raw perlite material with sheet like particles.

(b) Raw flour of pumice material showing pebble like particles.



(a) (b)

Fig 2.9 Micrographs of enamel polished by rubber cup *(21)*

(a) Enamel surface morphology (rubber cup plus perlite prophylaxis paste).

(b) Enamel surface morphology (rubber cup plus the flour of pumice prophylaxis paste).