

# The pre-treatment of enamel surface *in vitro* with Er:YAG laser for bonding composite resin

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## SUMMARY

The purpose of this study was to evaluate and compare the bond strength of a composite resin bonded to dental enamel etched by three different techniques: 1) only with Er:YAG laser (with three different energies per pulse: 60, 300 and 500 J), 2) phosphoric acid and 3) laser plus phosphoric acid.

The adhesive system was applied, cones of composite resin were bonded to the etched enamel surface and, after thermocycling, the bond strength was tested. The etched enamel surface was analysed with a Scanning Electron Microscope.

The bond strength values of the groups that were exclusively laser etched showed to be statistically lower than those of the other groups (laser + acid and only acid), the more the energy, the lower the bond strength.

The modification of the enamel surface by Er:YAG laser irradiation before acid etching can be seen to be an alternative technique for bonding composites.

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## INTRODUCTION

The acid etching technique was introduced by Buonocore in 1955 by conditioning the enamel surface with phosphoric acid.

Since then, variations in the kind of acid applied, its concentration and application time have been studied, as well as the feasibility of enamel surface modification by laser irradiation with the intent of preparing it for the application of bonding composites.

Among the existing lasers systems, Er:YAG is considered one of the best for this purpose because the emission wavelength of 2,94 $\mu$ m coincides with the main absorption peak of water and hidroxiapatite<sup>1</sup> (FRENTZEN; KOORT, 1992), results in good absorption in all biologic tissues<sup>2</sup> (KUMAZAKI, 1994). Its use in dental hard tissues as well as in carious lesions results in effective ablation without thermal injury to the surrounding hard tissues<sup>3</sup>. (HIBST; KELLER, 1995).

The purpose of this study was to evaluate the bond strength as well as to analyze by Scanning Electron Microscopy the dental enamel conditioned by three different techniques.

- Er:YAG laser irradiation (with three energies per pulse: 60, 300 and 500mJ)
- phosphoric acid etching
- Er:YAG laser irradiation plus acid etching

## MATERIALS AND METHODS

Fifty human extracted teeth were included in acrylic blocks with the buccal surface exposed so that this surface could be conditioned.

The specimens were divided into five groups of 10 teeth and were conditioned as follows:

The first group, called L1, was irradiated with Er:YAG laser with 60mJ of energy per pulse, repetition rate of 10Hz, total energy of 37J and energy density of 8.46J/cm<sup>2</sup>.

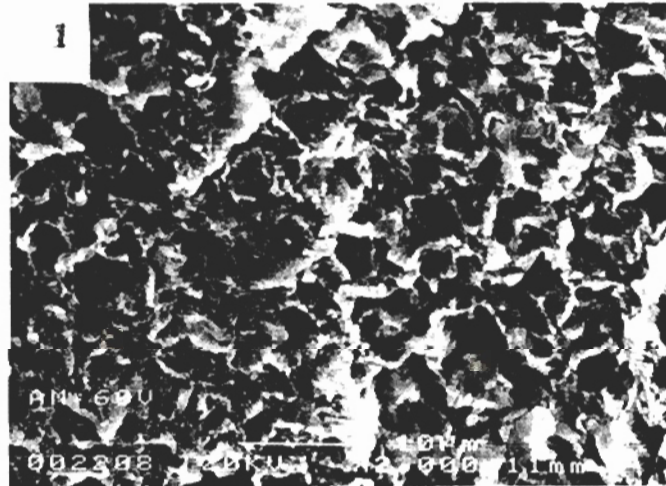


Fig 1 - Laser conditioning with Er:YAG laser (60mJ, 10Hz) pattern showing enamel ablation (2,000X)

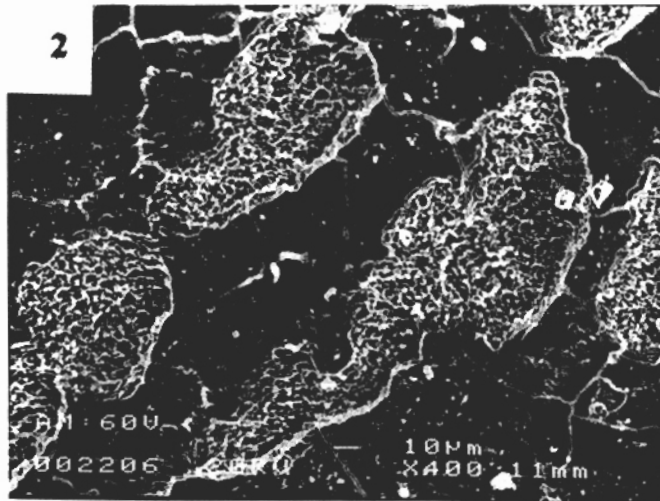


Fig 2 - Laser conditioning (60mJ, 10Hz) showing unattached regions (400X)

The group called L2 was irradiated with Er:YAG laser with 300mJ, 6Hz, total energy of 37 and ED of  $42.32\text{J}/\text{cm}^2$ .

In the L3 group the energy per pulse was 500mJ, the repetition rate 2Hz, total energy of 37J and energy density of  $70.54\text{J}/\text{cm}^2$ .

A fourth group was acid etched, using 37% phosphoric acid for 30 seconds and was called Ac group.

The fifth group, called LA, was double conditioned: first it was irradiated with Er:YAG laser in the same conditions as those of the group L1 (60mJ,10Hz) and after this, it was etched with 37% phosphoric acid for 30 seconds.

In all laser irradiated groups the *Kavo Key Laser 2* Er:YAG laser (pulse width 500  $\mu\text{sec}$ ) was used and the area for these irradiations was delimited to 4 X 4 mm.

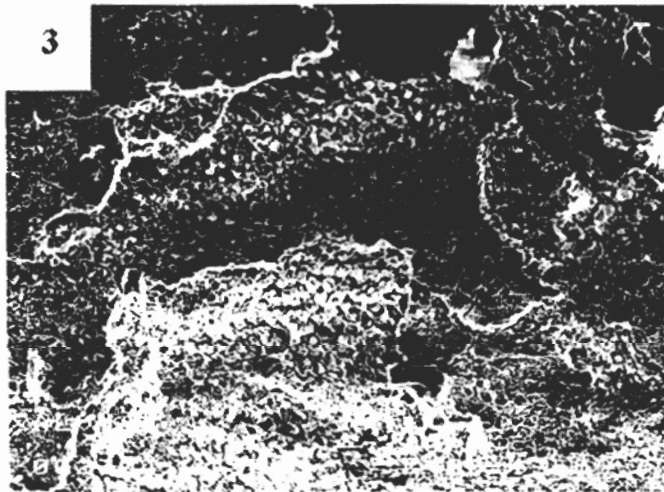


Fig 3 - Double mode conditioning (Er:YAG laser 60mJ, 10Hz plus phosphoric acid)

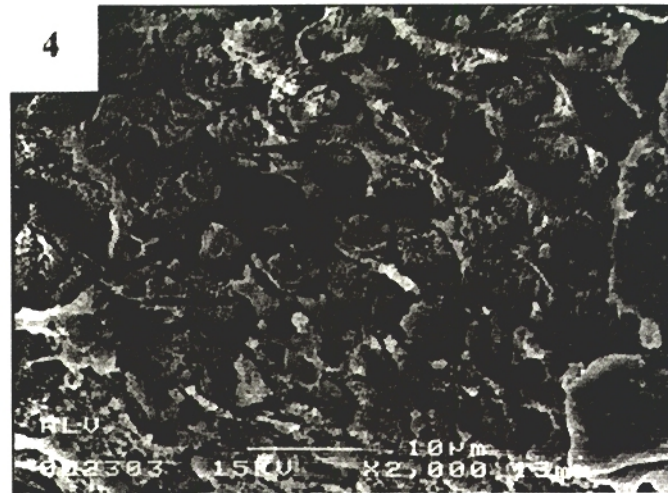


Fig 4 - The same surface of the fig 3 in high magnification (2,000X)

All specimens, after the application of the adhesive system (Pro-Bond/Dentisply) and the confection of composite cones (TPH/Dentisply), were thermocycled (700 cycles, 6°C e 55°C) and then the bond strength tests were performed.

The conditioned dental enamel was analyzed by Scanning Electron Microscopy ( JEOL - Electron Probe Microanalyser, JXA - 6400) and Calcium and Phosphorus concentration was analyzed by Energy Dispersive X-Ray Microanalysis (EDX).

## RESULTS

The Scanning Electron Microscopy showed that the laser irradiation caused ablation on the enamel surface. These alterations are similar to those caused by the phosphoric acid and by the double mode etching (laser + acid).

The bond strength tests showed the following results:

Groups	Ac	LA	L1	L2	L3
MPa	12.197	12.422	8.027	7.421	5.636

These data were statistically analyzed and showed to be homogeneous and normal, so a parametrical test could be used. The analysis of variance was found to be *highly significant* at the 1% level.

The contrast value, determined by the *Tukey Test* for a level of confidence of 1% is 2.89.

Consequently, It can be said that the values of bond strength are greater in the groups that used phosphoric acid in its conditioning (Ac and AL) than in that of the groups that were exclusively laser conditioned (L1, L2 and L3).

There is no difference, at the 1% level, between the acid etched group (Ac) and the double mode conditioning group (laser + acid, AL). There is

no difference between the groups that used only laser in their conditioning process.

### CALCIUM and PHOSPHORUS ANALYSIS

Condition	Ac	LA	L1	L2	L3	NO ETCH
% Ca	58.15	60.91	59.31	59.31	58.50	58.85
% P	41.85	39.09	40.69	40.69	41.50	41.15

### DISCUSSION AND CONCLUSIONS

The SEM analysis showed that the enamel surface etched by Er:YAG laser presented unattached regions. The presence of such regions could explain the lower bond strength values presented in this study by the groups with exclusively Er:YAG laser etching.

In the present study, the conditioning exclusively with Er:YAG laser showed to be lower with respect to bond strength than those groups that used phosphoric acid in their conditioning (acid etch group and laser + acid etch).

KAYANO<sup>4</sup> (1991) studying ablations with Er:YAG laser concluded that the surrounding enamel were more acid resistant. So, a possible advantage of the use of the double mode conditioning (laser plus acid) would be not just a surface with a very good etching pattern, but also a more carie resistant region too.

The modification of the enamel surface By Er:YAG laser irradiations before acid etching can be seen as an alternative technique for bonding composites.

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