Evaluation of the microleakage of photopolymerized condensable composite resin

F. Vantine[1], M. L. Redígolo[2], A. S. de Carvalho[1], E. Munin[2] and M. T. T. Pacheco[2]

[1]Faculdade de Ciências da Saúde (FCS)
Universidade de Vale do Paraíba (Univap), Brasil, 12244-000, Fone: +55 12 3947 1015
[2]Instituto de Pesquisa e Desenvolvimento (IP&D)
Universidade de Vale do Paraíba (Univap), Brasil, 12244-000, Fone: +55 12 3947 1128
fvantine@univap.br, redigolo@univap.br, munin@univap.br

Abstract

This study compares the microleakage of a composite resin polymerized by using a commercial halogen lamp or an Argon laser operating in both single or multiline mode. For the microleakage experiment thirty restorations were prepared with the condensable composite resin in fifteen human superior premolars (two restorations per tooth). The restorations were divided into three groups: I - Cured with a commercial halogen lamp-based photopolymerizer; II – Cured with an Argon laser (488 nm) and III – Photopolymerized with an Argon laser on its multiline mode. All samples were sanded, polished and submitted to 300 thermal cycles with the low and high temperature settled at 5 °C and 55 °C respectively, alternating with 37 °C to avoid fatigue of the junction of these materials. Then, they were immersed in a 2 % basic fucsin solution at room temperature for a period of 24 h. After dye immersion, they were longitudinally cut into two parts for observation. Three different observers analyzed the microleakage of each part using a score system, where the largest infiltration degree received the highest numeric value. The score system were also validated through energy dispersive spectroscopy (EDS) under the scanning electron microscope JSM 5900LV of the Electron Microscopy Laboratory (LME), at the Brazilian Synchrotron Light Laboratory (LNLS), Campinas. Comparing all the scores for microleakage, the best results were obtained for the samples polymerized by the Argon laser in the multiline operational mode (group III). The samples cured by the halogen lamp (group I) presented the largest dye infiltration degree.

Introduction

In 1968, the use of the laser in medicine became subject of great interest due to the appearing of the Argon laser that allows a greater control by the operator during surgical procedures. [1]

Nowadays, its use is under study in dentistry for many applications such as caries removal, reduction of dentin hypersensitivity, surgical procedures, composite resin photopolymerization, etc. [1]

The current-day clinical practice of dentistry involves not only the prevention, diagnosis and treatment of teeth diseases but also the commitment with the final aesthetic result from all those procedures. This concern with cosmetic dentistry has stimulated the interest in new esthetical materials, and more precisely the composite resin as a substitute for the amalgam. [2]

During all the evolution period of the composite resins, there was always the concern about optimizing the effectiveness of the charges embedded in the host matrix through a variety of sizes, to introduce the maximum number of particles per volume and then to improve the mechanical properties of these materials, since the less the quantity of the host matrix the better the resistance to the composite resin wear. [3]

To solve problems related to the polymerization degree of these composite resins, new equipments capable of delivering higher intensities of light (the photopolymerization agent) were introduced in the market, including the argon laser.

Considering these resins and the importance of knowing their properties, the aim of this work is to study an specific class of composite resin: the condensable one. We evaluate the condensable composite resin when photopolymerized with an argon laser or a commercial halogen lamp-based photopolymerizer through Vickers hardness test and a microleakage experiment.

Experimental Setup

For the hardness tests, thirty samples of condensable composite resin (Filtek™ P60, C2 colour - 3M) were prepared in anaesthetic tubes with 3 mm of height and 7 mm of diameter cut by a carborundum sandpaper. All samples were sanded and polished before the photopolymerization process.

These samples were divided into three groups: I - cured with a commercial halogen lamp-based photopolymerizer; II – cured with an argon laser light (488 nm) and III – photopolymerized with an argon laser on its multiline mode. This laser in both operational modes (488 nm or multiline) and power of 400 mW was applied to the specimens for 40 s.

All samples were submitted to the Vickers hardness test with a load of 25 gf. After the calculation of the arithmetic mean for each group, the results were compared to each other.

For the microleakage experiment thirty restorations were prepared with the same composite resin in fifteen human superior premolars (two restorations per tooth). The restorations were divided into three groups and received the same photopolymerization processes as those already described for those samples prepared for the hardness test. These samples were sanded, polished and submitted to 300 thermal cycles with the low and high temperature settled at 5 °C and 55 °C respectively, alternating with 37 ^{o}C to avoid fatigue of the junction of the materials. Then, they were immersed in a 2 % basic fucsin solution at room temperature for a period of 24 h.

After dye immersion, they were longitudinally cut into two parts for observation. Three different observers analyzed the microleakage of each part using a score system, where the largest infiltration degree received the highest numeric value and vice-versa, as presented in Table 1. [4]

Table 1 – Scores as a function of the samples infiltration degrees

SCORES
0 - No infiltration in the dentin/restoration interface.
1 - Presence of infiltration in the enamel.
2 - Presence of infiltration in the enamel and in the dentin.
3 - Presence of infiltration in the enamel, the dentin and in the pulp.

Results and Discussions

The result obtained through the Vickers hardness test for Group I was (144 ± 2) gf / mm^2. Groups II and III presented the following values respectively: (170 ± 6) gf / mm^2 and (176 ± 4) gf / mm^2.

These statistical analyses show that the argon laser has a more effective influence on the hardness of the photopolymerized resin independently of operating in the single or multiline mode.

Comparing all the scores for microleakage, the best results were obtained for the samples polymerized by the Argon Laser in the multiline operational mode (group III). The samples cured by the halogen lamp (group I) presented the largest dye infiltration degree. These data are presented in Table 2.

Table 2 – Number of samples that received the same score for each photopolymerization method adopted.

Scores:	**Number of samples**		
	Halogen Lamp	**Argon Laser (488 nm)**	**Argon Laser (multiline)**
0	0	0	2
1	4	8	7
2	3	1	1
3	3	1	0

Since the number of the samples was the same for all groups, the score results can be used as basis to evaluate the microleakage through an weighted sum as follows:

$$\frac{1}{n}\sum_{s=0}^{3} n_s.s \quad , \qquad (1)$$

where s is the *score* obtained and n_s is the number of samples with *score s*.

For the groups photopolymerized with the halogen lamp, the argon laser at 488 nm and the argon laser at the multiline operational mode, the results obtained by using equation (1) are 19, 13 and 9, respectively, considering 10 specimens in each group.

The score system were also validated through energy dispersive spectroscopy (EDS) under the scanning electron microscope JSM 5900LV of the Electron Microscopy Laboratory (LME), at the Brazilian Synchrotron Light Laboratory (LNLS), Campinas. In figures 1 and 2, the regions selected for the EDS analysis (photomicrographs on the right side) are compared to their optical microscopy pictures (on the left side). The graphs 1 and 2 shows the difference between the EDS analysis for the regions that presented or not fucsin dye infiltration.

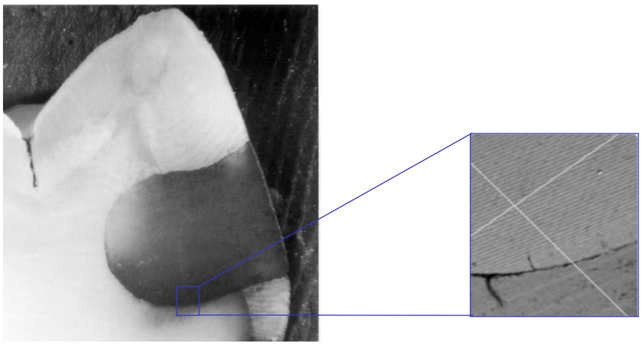


Figure 1 – Optical and electron microscopy of a sample's dyed region.

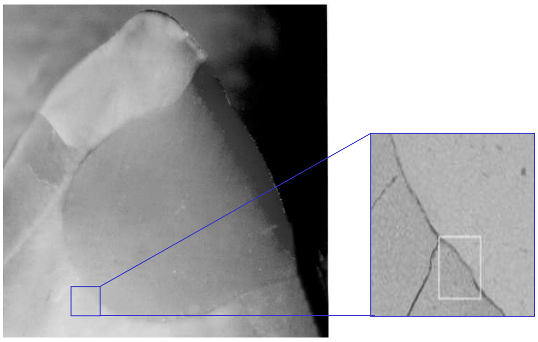
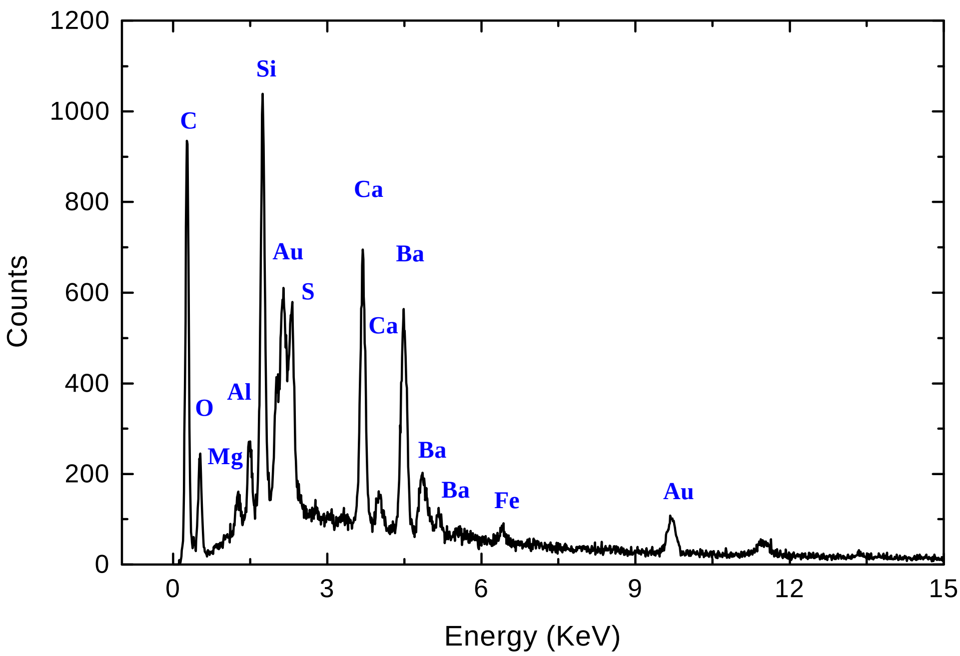
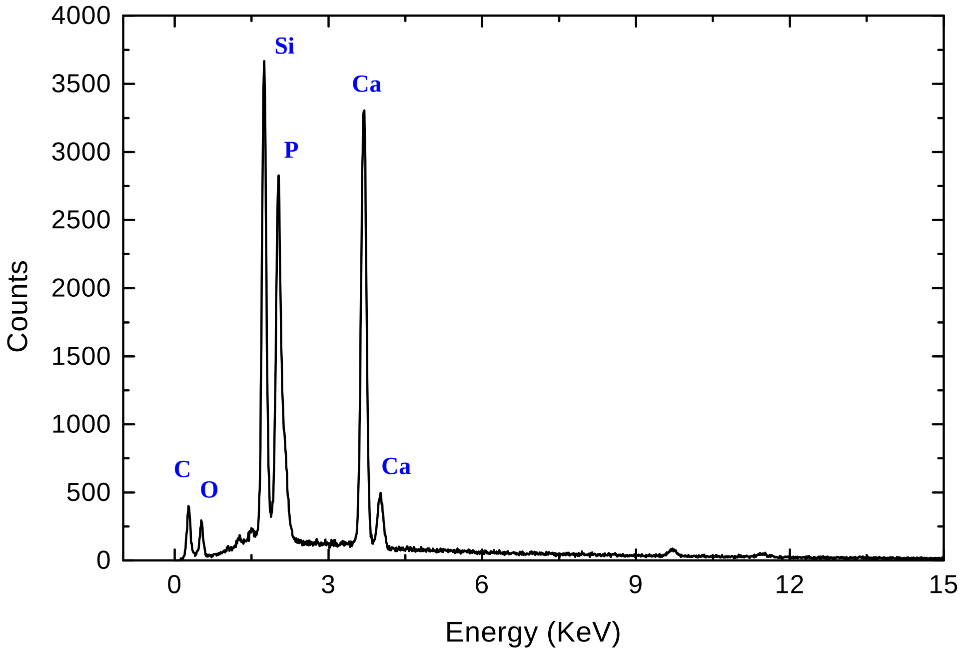


Figure 2 – Optical and electron microscopy of a sample's non-colored region.



Graph 1 – EDS analysis performed in the region marked in figure 1 (dyed region).



Graph 2 – EDS analysis performed in the region marked in figure 2 (non-colored region).

Conclusions

Comparing all the data obtained in our experiments, the resin presented the best combination of results for the surface hardness and the microleakage when cured by the argon laser working on its multiline operational mode.

The samples polymerized by the argon laser at 488 nm have shown in the sequence the best results. The less effective result was obtained for the sample group cured with the commercial halogen-lamp based photopolymerizer.

References

[1] H. A. Wigdor, "Lasers in dentistry", Lasers in Surgery and Medicine **16**, pp. 103-133, 1995.
[2] K. H. Chung, "The relation between composition and properties of posterior resin composites", J. Dent. Res. **69**, pp. 852-856, 1990.
[3] P. T. Williams and L. N. Johnson, "Composite resin restoratives revisited", J. Can. Dent. Assoc. **59** (6), pp. 538-543, 1993.
[4] B. B. Lee and G. E. White, "Chamfered margin effects on microleakage of primary molar class I composite resin restorations *in vitro*", J. Clin. Pediat. Dent. **22** (2), pp. 113-115, 1998.