Original Article

Effect of Different Powers of Er,Cr:YSGG Laser Treatment on Surface Morphology of Microhybride Composite Resin: Scanning Electron Microscope (SEM) Evaluation

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Abstract:

Introduction: The aim of this study was to evaluate and compare microhybride composite treated by bur and different power of Erbium, Chromium doped Yttrium Scandium Gallium Garnet (Er,Cr:YSGG) laser by Scanning Electron Microscope (SEM).
Methods: 21 microhybride composite blocks (DiaFil TM, DiaDent, Korea) with 2 × 4 × 4 mm dimensions were made. The bonding surface of these blocks were polished, The samples were put into 6 groups for laser irradiation as follows: Group 1 (power: 1W, Energy: 50 mJ); Group 2(power: 2 W, Energy: 100mJ); Group 3 (power: 3W, Energy: 150mJ); Group 4 (power: 4W, Energy: 200mJ); Group 5 (power: 5W, Energy: 250mJ) and Group 6(power:6 W, Energy:300mJ). One group prepared by bur- treated. All samples were prepared by repetition rate of 20 Hz. Then, the samples were prepared for SEM examination.
Result: Some irregularities were seen in Er,Cr:YSGG laser samples in comparison to Bur group that produced favorable surface for adhesion of repair composite.
Conclusion: Among different lasers, Er;Cr:YSGG laser can be chosen as a suitable technique for surface treatment of unsatisfactory composites.
Keywords: SEM evalution; laser; composite resin

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Introduction

Resin composite is a widely used material in direct restorative procedures. After a period of service, most resin restorations develop defects resulting from wear, fracture, or discoloration.[1]

Defective composite resin restorations do not necessarily require complete removal. Based on the minimally invasive restorative concept,[2] repair may be considered as the treatment of choice. Repair makes it possible to preserve dental structure, reduce serious jeopardy to the pulp tissues, and lower costs.[3-5]

For this purpose, various chemical and mechanical surface treatment to improve bonding of composites, but also various methods to increase the bond strength between old and new have been suggested in several studies.

Laser is one of the methods of surface treatment used to improve micromechanical retention and bond strength and it has been widely used in many specialties of dentistry.

Nowadays, laser causes less pain, reduces the need for anesthesia in dentistry, increases bond strength and has played an important role in dental treatment. Laser has many applications and much research has been focused on it.

Among different lasers used in dentistry, Erbium lasers are considered as the best option for caries removal and cavity preparation. This family has two wavelengths including Er:YAG laser (2940 nm) and Erbium, Chromium doped Yttrium Scandium Gallium Garnet (Er;Cr: YSGG) laser (2780 nm).[6]

The aim of this study was to evaluate and compare microhybride composite resin treated by different power of Er,Cr:YSGG laser (1-6 w) and diamond bur by Scanning Electron Microscope (SEM).

Methods

21 microhybride composite blocks (DiaFil TM, DiaDent,Korea) with 2 × 4 × 4 mm dimensions were made. The bonding surface of these blocks were polished using 600 grit silicon sandpaper for 15 seconds under running water to make an even surface.

The samples were put into 6 groups for Er;Cr: YSGG laser irradiation as follows: Group 1 (power: 1W, Energy:50 mJ); Group 2(power: 2 W, Energy:100 mJ); Group 3 (power: 3W, Energy:150 mJ); Group 4 (power: 4W, Energy: 200 mJ); Group 5 (power: 5W, Energy: 250 mJ) and Group 6(power:6 W, Energy:300 mJ). One group prepared by bur- treated. All samples were prepared by repetition rate of 20 Hz. This preparation was accompanied by air (60%) and water (30%) spray. all surfaces were prepared by tip MZ8.

After that, the surfaces were evaluated using Scanning Electron Microscope (SEM) analysis. Samples were fixed in 2.5% Glutaraldeheyde for 12 hours (4°C), and then dehydrated in ascending grades of ethanol (25%, 50%, 75%, 90% and 100%). Then, the samples were dried and sputter-coated with gold[7]. Finally, prepared surfaces were analyzed with a scanning electron microscope at ×500, ×1000, ×2000 and ×5000 magnification.

Results

Under SEM evaluation, in the laser group, cleaned ablated surfaces with no smear layer production could be seen. The surfaces treated by Er,Cr:YSGG laser showed irregular and micro porous surfaces. The surface which was prepared by output power of 4, 5 and 6W showed more irregularity than output power of 1, 2 and 3 W (Figure 1-12). In the other hand, the group prepared by bur showed noticeable smear layer (Figure 13, 14).

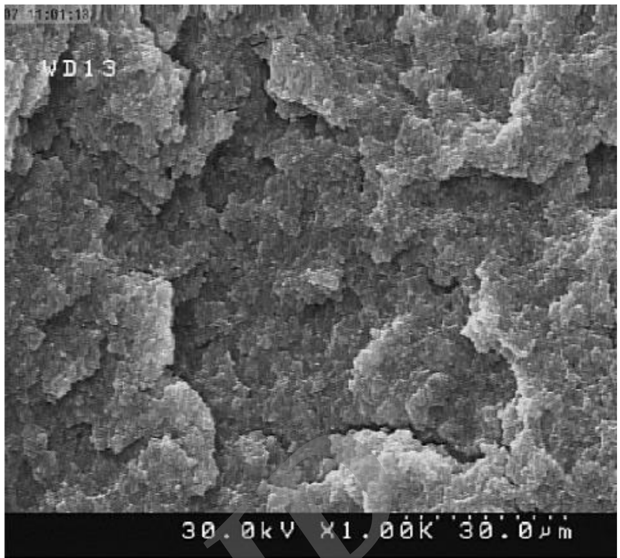

Figure 1. Surface treated by Er,Cr:YSGG laser with output power of 1 W (Original magnification ×1000, bar=30μm)

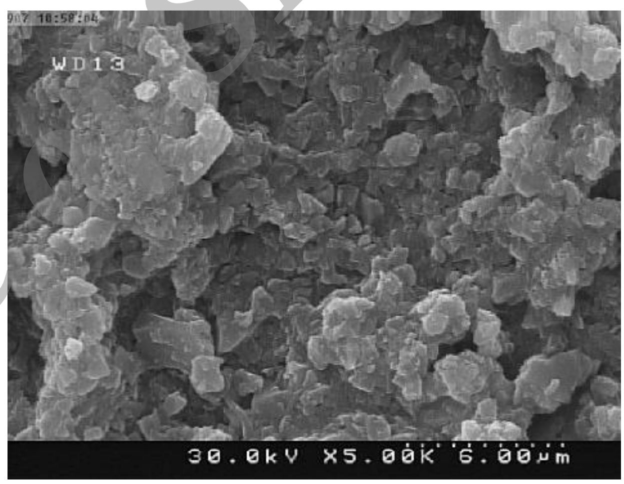

Figure 2. Surface treated by Er,Cr:YSGG laser with output power of 1 W (Original magnification ×5000, bar=6μm)

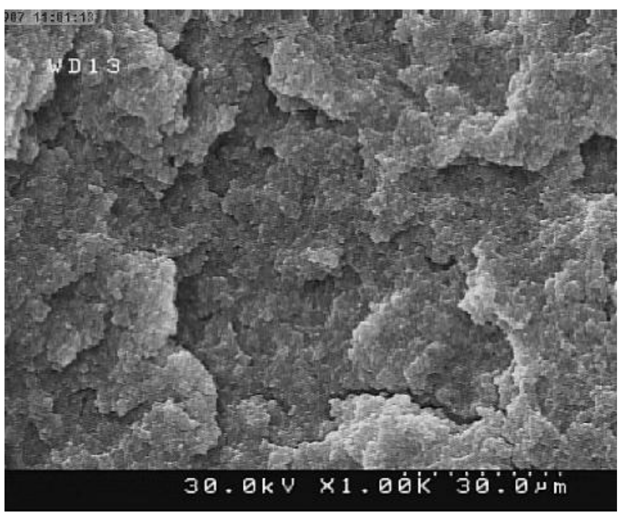

Figure 3. Surface treated by Er,Cr:YSGG laser with output power of 2 W (Original magnification ×1000, bar=30μm)

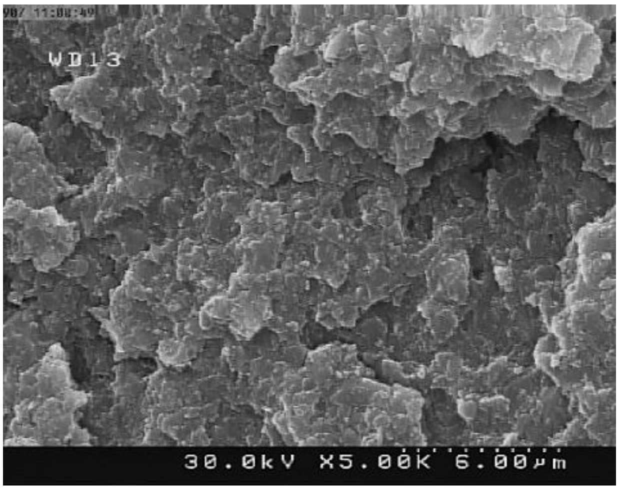

Figure 4. Surface treated by Er,Cr:YSGG laser with output power of 2 W (Original magnification ×5000, bar=6μm)

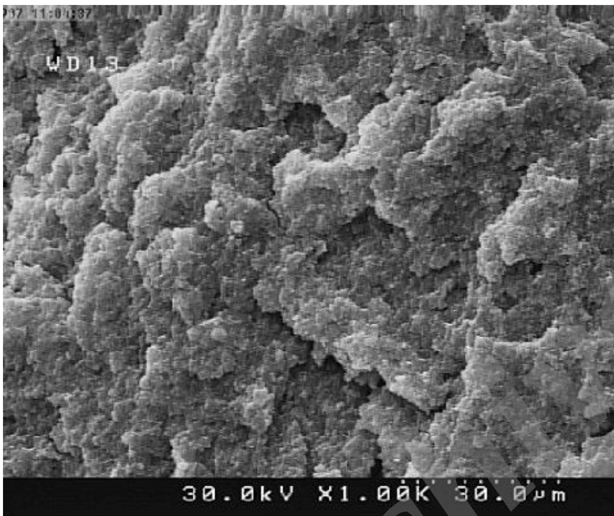

Figure 5. Surface treated by Er,Cr:YSGG laser with output power of 3 W (Original magnification ×1000, bar=30μm)

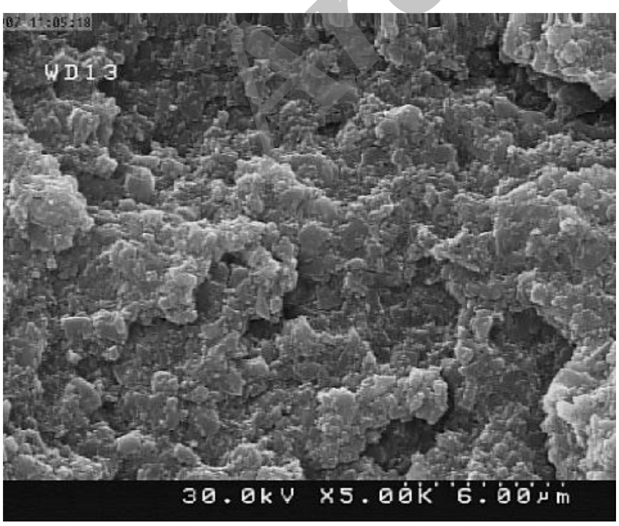

Figure 6. Surface treated by Er,Cr:YSGG laser with output power of 3 W (Original magnification ×5000, bar=6μm)

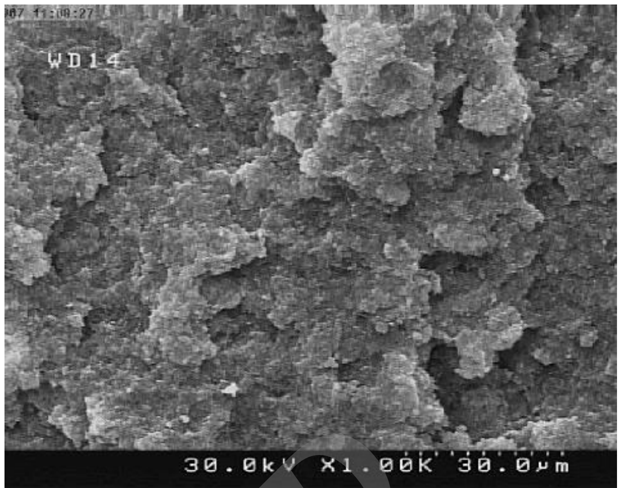

Figure 7. Surface treated by Er,Cr:YSGG laser with output power of 4 W (Original magnification ×1000, bar=30μm)

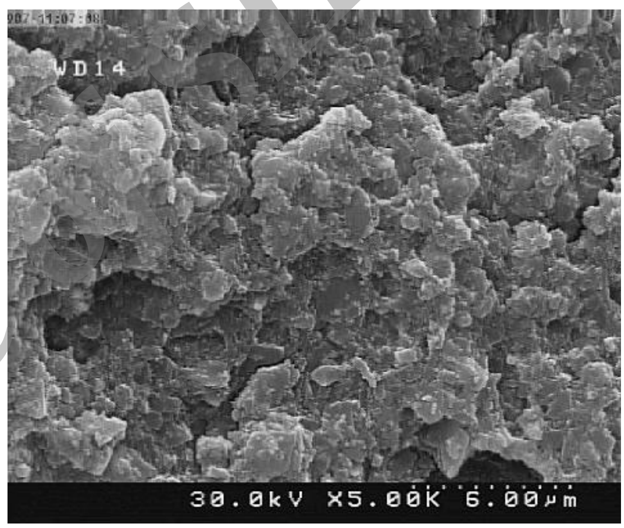

Figure 8. Surface treated by Er,Cr:YSGG laser with output power of 4 W (Original magnification ×5000, bar=6μm)

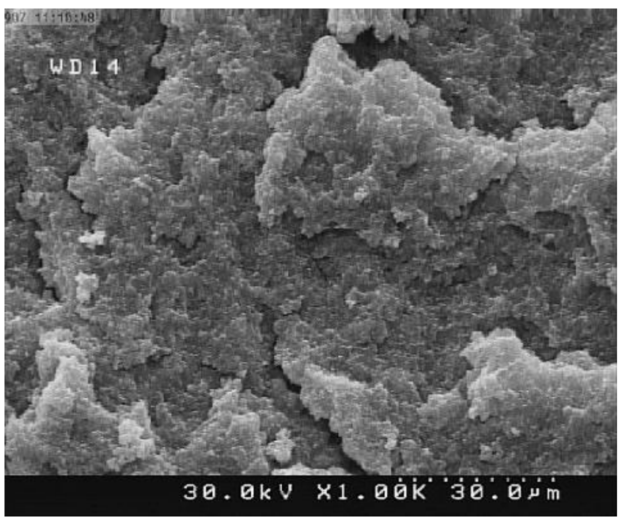

Figure 9. Surface treated by Er,Cr:YSGG laser with output power of 5 W (Original magnification ×1000, bar=30μm)

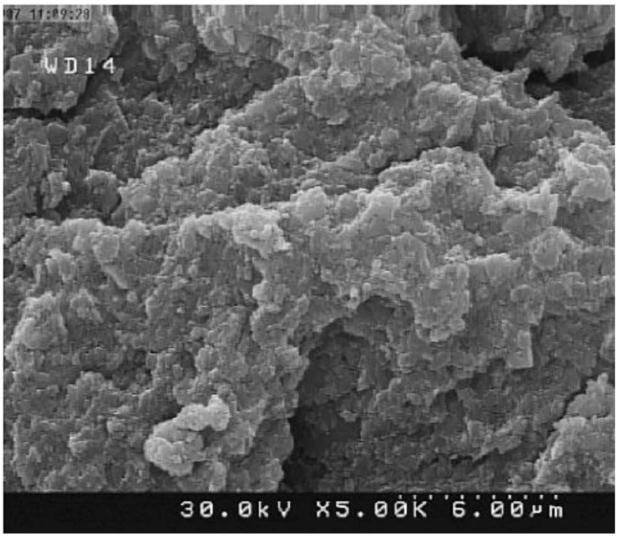

Figure 10. Surface treated by Er,Cr:YSGG laser with output power of 5 W (Original magnification ×5000, bar=6μm)

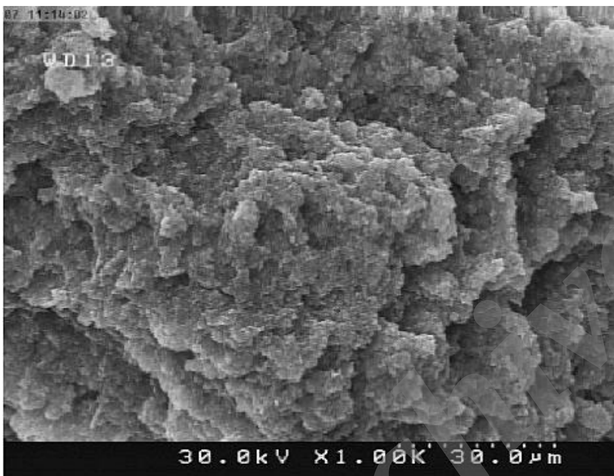

Figure 11. Surface treated by Er,Cr:YSGG laser with output power of 6 W (Original magnification ×1000, bar=30μm)

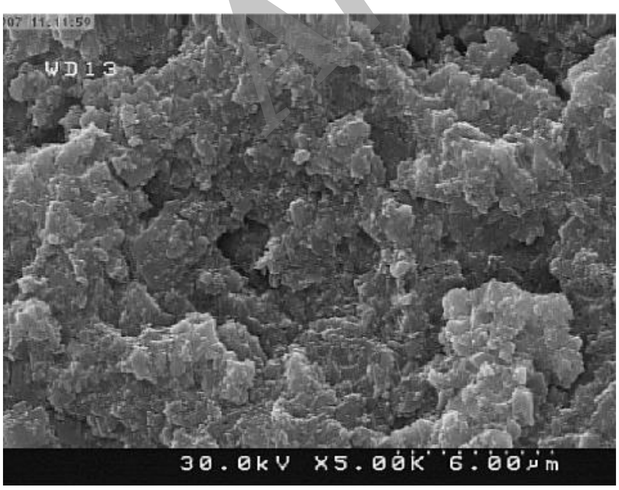

Figure 12. Surface treated by Er,Cr:YSGG laser with output power of 6 W (Original magnification ×5000, bar=6μm)

Figure 13. Surface treated by Bur (Original magnification ×1000, bar=30μm)

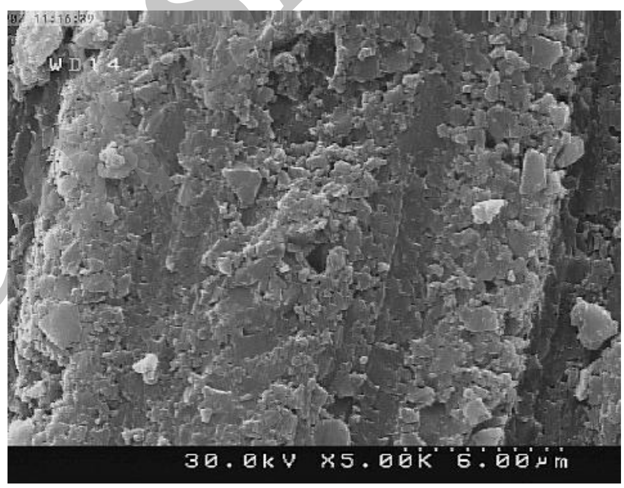

Figure 14. Surface treated by Bur (Original magnification ×5000, bar=6μm)

Discussion

The ideal adhesive material should have similar physicochemical characteristics of dental hard tissue and show the least shrinkage during polymerization[8]. Some studies have shown that the application of indirect composites reduced the bond strength 25-80%.[9]

Interlocking is one of the most important factor for repairing composite which approved by several researchers[10, 11, 12]. Achieving to better mechanical interlocking is provided by increasing the surface roughness[13].

bonstein et al.[14] indicated that surface treatment by diamond bur led to higher bond strength compared to other techniques. On the other hand, several studies showed that grinding composite surface resulted in smear layer formation[10,15]. On contrary, laser irradiation ablate the composite resin without smear layer production[16]. Laser surface treatment of composite resin produced higher bond strength rather than bur preparation due to negative effect of smear layer produced by bur treatment[10].

Along with our results, Kimyai et al.[10] reported that the irradiation of Er,Cr:YSGG laser produced higher bond strength compared to bur treatment. The differences between two studies were related to different types of composite used, given that the composite structure can have an effect on mechanical properties of surface treatment[17, 18].

In the current study, irregularities with no particular pattern were observed in laser irradiated group. By increasing the power, these changes were also enhanced.

Conclusion

Based on the evaluation of treated composite surfaces, Er,Cr:YSGG laser can be used as an alternative technique for surface treatment of unsatisfactory composites. There is still need to do more researches to find the best protocol for achieving the best bonding.

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