1070 NM FIBER LASER SHORT PULSES LASER IRRADIATION ON ZIRCONIA SURFACE: MORPHOLOGICAL, CHEMICAL, THERMAL AND MECHANICAL ANALYSIS

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This in vitro study aimed to observe the effect of 1070 nm fiber short pulses laser on zirconia samples by morphological analysis (profilometry, SEM), thermal recording (FBG), elemental composition (EDX) and strength bond (mechanical tests)
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1. Introduction

In the last two decades, the continuous progression in the ceramic materials science for dental applications has permitted the fabrication of high-strength materials and, among them, zirconia- based ceramics have improved in terms of fracture resistance and long-term viability in comparison with other silica-based materials.[1]
Unfortunately, while the resin cement–silica ceramics bond can be strengthened through creating a porous surface by applying hydrofluoric acid (5%–9.5%) and a subsequent silane coupling agent, the glass-free polycrystalline microstructure of zirconia ceramics does not allow such reaction.[2]
The aim of this *in vitro* study was to see the effects of laser irradiation on zirconia surfaces.

2. Materials and Methods

50 plates of zirconia (DDBioZ, Dental Direkt GmbH, Spenge, Ger) of 12 x 15 x 2 mm were divided in 4 groups (A:5 samples, B: 5 samples, C: 6 for samples and D: 34 samples).
The samples of the group A were irradiated at different parameters and were used for the surface analysis, the samples of the group B were irradiated at different parameters and used for the thermal analysis, the samples of the group C were irradiated at different parameters and utilized for the SEM and EDX analysis while the samples of the group D were randomly divided in two subgroups of 17 samples, one irradiated in a circular area of 5 mm diameter at a repetition rate (RR) of 20 kHz; output powers of 5kWand a speed of 50 mm/s. Thus, the cylinders were divided in two groups: six samples were irradiated at a speed of 10 mm/s (group A) and six at 50 mm/s (group B), the other non-irradiated and used as control group, and were utilized for the mechanical tests.

3. Results and Discussion

The results of the profile analysis showed that, in all the processed samples, a very high rugosity (around 10 µ) was produced and also that, at the speed used, there was a good overlapping between the laser spots.
FBG analysis showed a slight thermal elevation which decreased just after irradiation.
SEM observation showed the presence of cracks in the areas irradiated by the laser at 100% power.
Compositional analysis of the irradiated areas showed a slightly larger variability without appreciable variation of the atomic percentages of C, O or Zr with respect to non-irradiated areas.
The statistical analysis of shear bond measurements showed a difference between the two groups, even if not significant.

4. Conclusion

Even if the fiber laser emitting at 1070 nm demonstrated to be able, with proper parameters, to improve the zirconia surface roughness without important thermal damages, moreover the comparison between irradiated and unirradiated samples didn't show statistically significant differences by the strength bond point of view.

References

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