Direct Laser writing-based surface texturing for enhanced adhesion between zirconia (3Y-TZP) and resin-matrix cement

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Introduction

Metallic implants

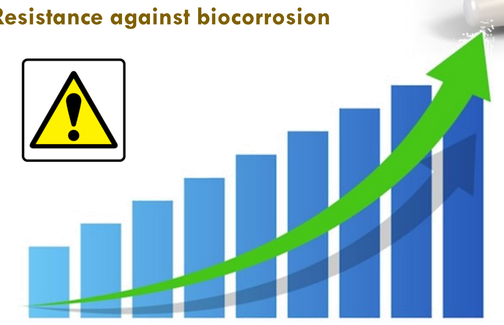
✖ Allergy to Metals

ALLERGY

✓ Demand for aesthetics

✓ Resistance against biocorrosion

All-Ceramic implants & restorations



Growing Demand for All-Ceramic restorations, Implants Presenting A billion-dollar industry

3-mol%Yttria-Stabilized Tetragonal Zirconia Polycrystal (3Y-TZP) has been widely used in the dentistry due to its **biocompatibility, tooth-like color and mechanical properties.**

However, its chemical **inertness** and high **crystalinity** makes surface modification challenging. Hence weak **adhesion**

Limitations of conventional method

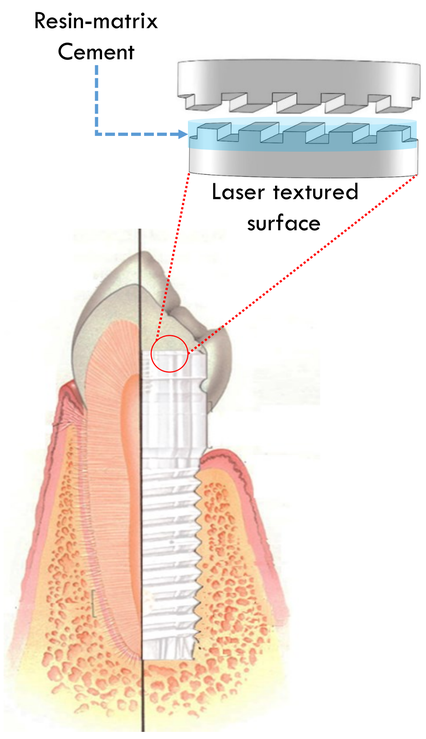
- **Random topography;**
- **Operator have no control;**
- **Damages to material properties;**
- **Jeopardizing lifespan.**

Advantages of Direct Laser Writing(DLW)

- **Contamination free;**
- **Controlled topography;**
- **Operator sensitive**
- **No damage to internal structure of material;**
- **possibility of process automation.**

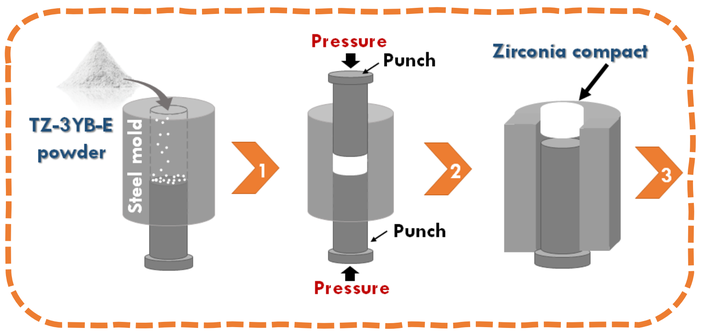
Proposal Solution

- This work presents direct laser writing (DLW) as an alternative method for surface modification of 3Y-TZP.
- The objective of the work is to increase the bond strength significantly.
- To match the life span of restorations to the life span of the patients.

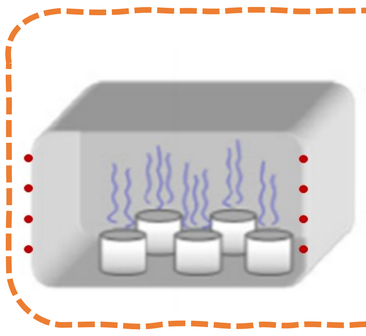


Experimental

STEP 1 – Disc Production (Cold pressing)

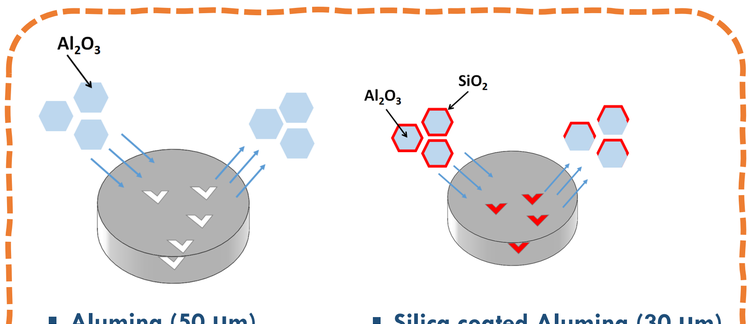


Sintering



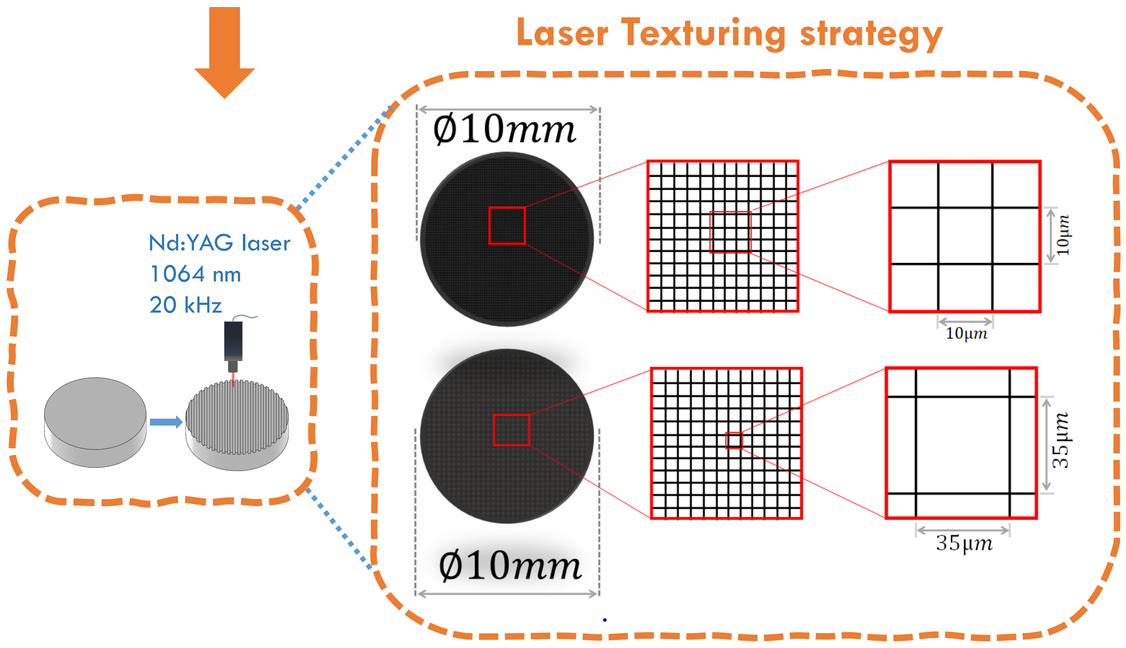
- Sintering temperatures $T = 1500°C$
- Hold time $t = 2$ hours
- Heating & Cooling rate $rate = 8°C/min$

Grit blasting

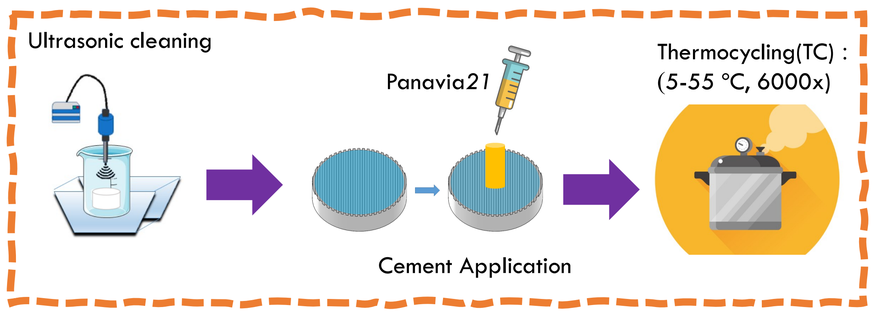


- Alumina (50 µm)
  - 20 s. 2.5 bar
- Silica coated Alumina (30 µm)
  - 20 s. 2.5 bar

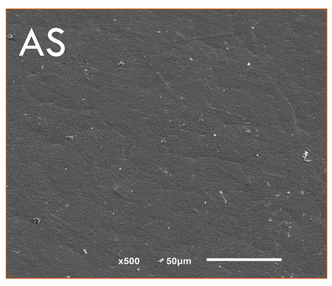
Laser Texturing strategy

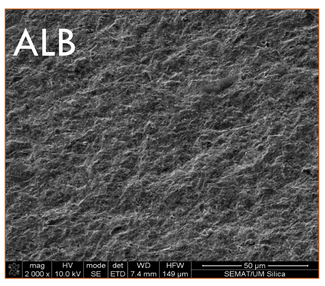


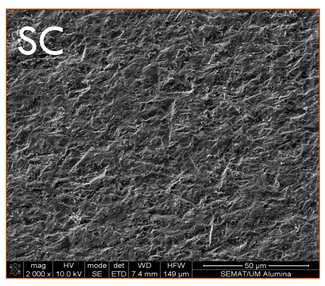
Cementation process

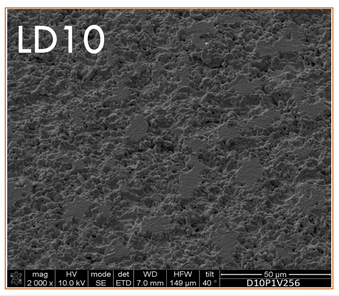


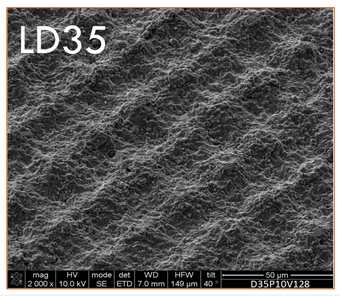
Results



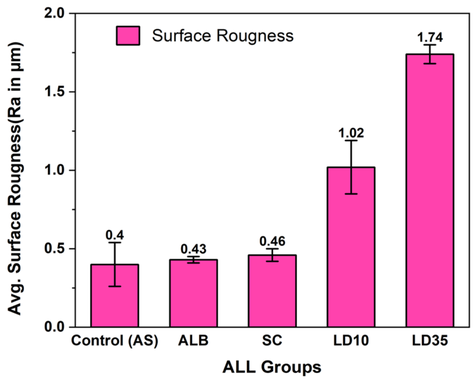


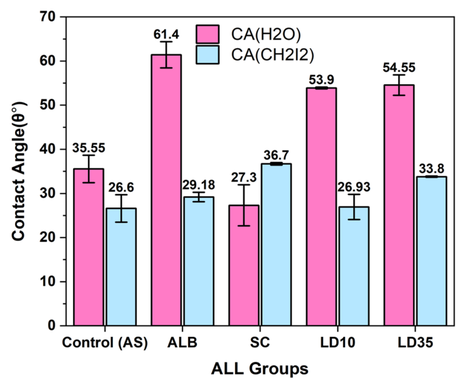


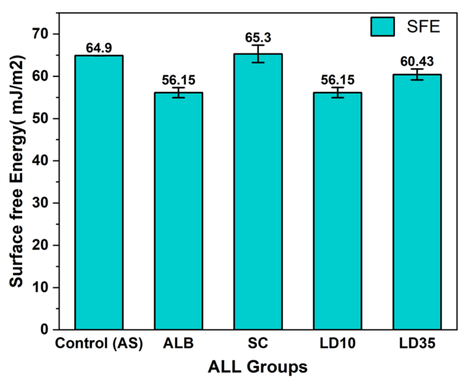


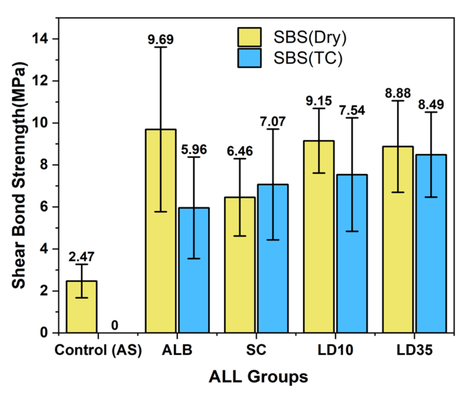


AS: As Sintered ; ALB: Alumina; SC: Silica coated alumina;
LD10: Laser (Power 0.06 W; Scanning velocity 256 mm/s; 10 µm crossed line pattern)
LD35: Laser (Power 0.6 W; Scanning velocity 128 mm/s; 35 µm crossed line pattern)









Conclusions

- Nd:YAG laser (1064 nm) used for direct laser writing of zirconia(3Y-TZP)
- Laser successfully produced controlled patterns
- Laser texturing increased surface roughness and modified surface morphology.
- Increased surface roughness produced higher bond strength.
- Bond strength after thermocyling(TC) was higher for both laser treated groups.
- Laser texturing can replace convectional grit blasting for surface modification.

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