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New method for depth analysis of Y-TZP t-m phase transformation

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Purpose/aim: The aim of this study was to validate the optical coherence tomography (OCT) as a nondestructive method of analysis to evaluate the depth of tetragonal to monoclinic (t-m) transformed zone and to calculate the kinetics of phase transformation of a monolithic Y-TZP after hydrothermal aging. Specifically, to compare the activation energy of t-m transformation calculated by the depth of the transformed zone using scanning electron microscopy (SEM) and OCT.

Materials and methods: Fully sintered (1450 °C/2 h) discs of dental Y-TZP (LAVA PLUS, 3M-ESPE) were aged in hydrothermal pressurized reactor to follow the phase transformation kinetics at 120 to 150 °C. Four samples per aging time were analyzed by OCT (OCP930SR, Thorlabs Inc.), λ = 930 nm, spectral bandwidth (FWHM) of 100 nm, nominal resolution of 6 μm (lateral and axial) in air, declared digital resolution 3.09 μm (axial). Three areas of 3 mm (lateral) were observed to calculate the phase transformation depth (Image J). X-ray diffraction analysis (XRD) were performed, Cu-Kα, 20° to 80°, 2θ. The data were refined using the Rietveld method (GSAS). The transversal section of one specimen of each group was submitted to backscattered SEM analysis to calculate the phase transformation depth (Image J). The speed of the transformation zone front was determined plotting the phase transformation depth versus aging time.

Results: XRD results indicated that Y-TZP that 66% is the maximum value of monoclinic phase concentration for all aged Y-TZP. The activation energy for the monolithic Y-TZP was 107.53 kJ/mol. One year and 5 years of hydrothermal aging at 37 °C will present approximately 4.21% and 15% of monoclinic phase, respectively. The comparison of the depth of the transformed zone using SEM and OCT were similar, showing a linear behavior and providing information that the opaque layer observed by OCT is related to the depth of the transformed zone (Fig. 1), any difference among the results could be a result of the refraction index correction. The energy of activation calculated by SEM and OCT were 114 kJ/mol and 100 kJ/mol, respectively. The speed calculated for the phase transformation into the bulk of the transformed zone estimated for 37 °C was 0.04 μm/year (SEM) and 0.16 μm/year (OCT).

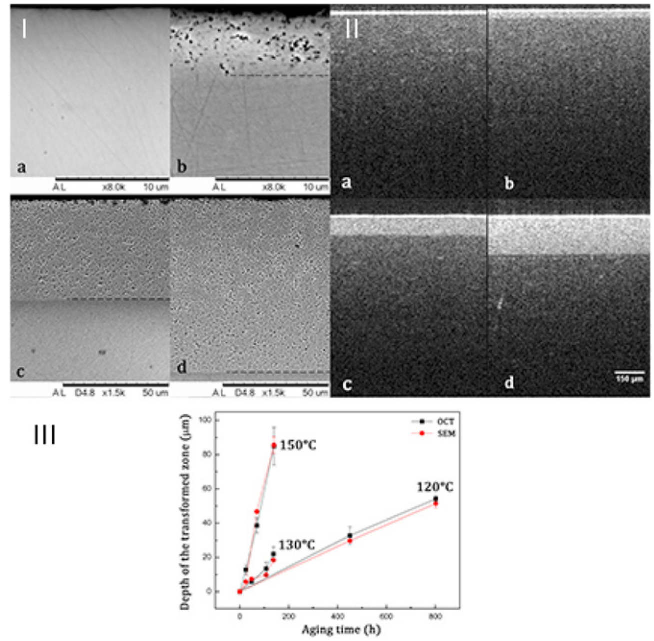

Fig. 1 – (I) SEM images comparing the depth of phase transformation zone after hydrothermal aging at (a) 0 h; (b) 25 h; (c) 70 h; (d) 140 h. (II) OCT images comparing the depth of phase transformation zone after hydrothermal aging at (a) 0 h; (b) 25 h; (c) 70 h; (d) 140 h. (III) Comparison between SEM and OCT data of the t-m phase transformation depth after aging as a function of hydrothermal aging time in different temperature.

Conclusions: The results indicate that activation energy values determined by SEM and OCT observations were similar allowing the use of the OCT as a tool for monolithic Y-TZP t-m phase transformation kinetic evaluation. Moreover, OCT method has the advantage of a shorter analysis time, without the need of sample preparation steps.

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Bulk-fill composite modulates specific virulence factors of S. mutans biofilm

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Purpose/aim: The aim of this study was to evaluate the effect of two bulk-fill composites in gene expression of Streptococcus mutans (S. mutans) at 24 h.

Materials and methods: Eighteen disks (4 × 2 mm) were prepared for each group: Filtek Bulk Fill (3M ESPE) and Tetric N Ceram Bulk Fill (Ivoclar Vivadent), experimental groups, and IPS e-MAX (Ivoclar Vivadent), control group. Following ceramic disks production, the composites disks were made in a laminar flow hood under aseptic conditions according to manufacturer's instructions. All the samples were sterilized by UV light and left into wells of a 24-well microplate. Medium