Influence of the photopolymerization unit angulation on Microhardness, Biaxial flexural strength and degree of conversion of bulkfill composites.

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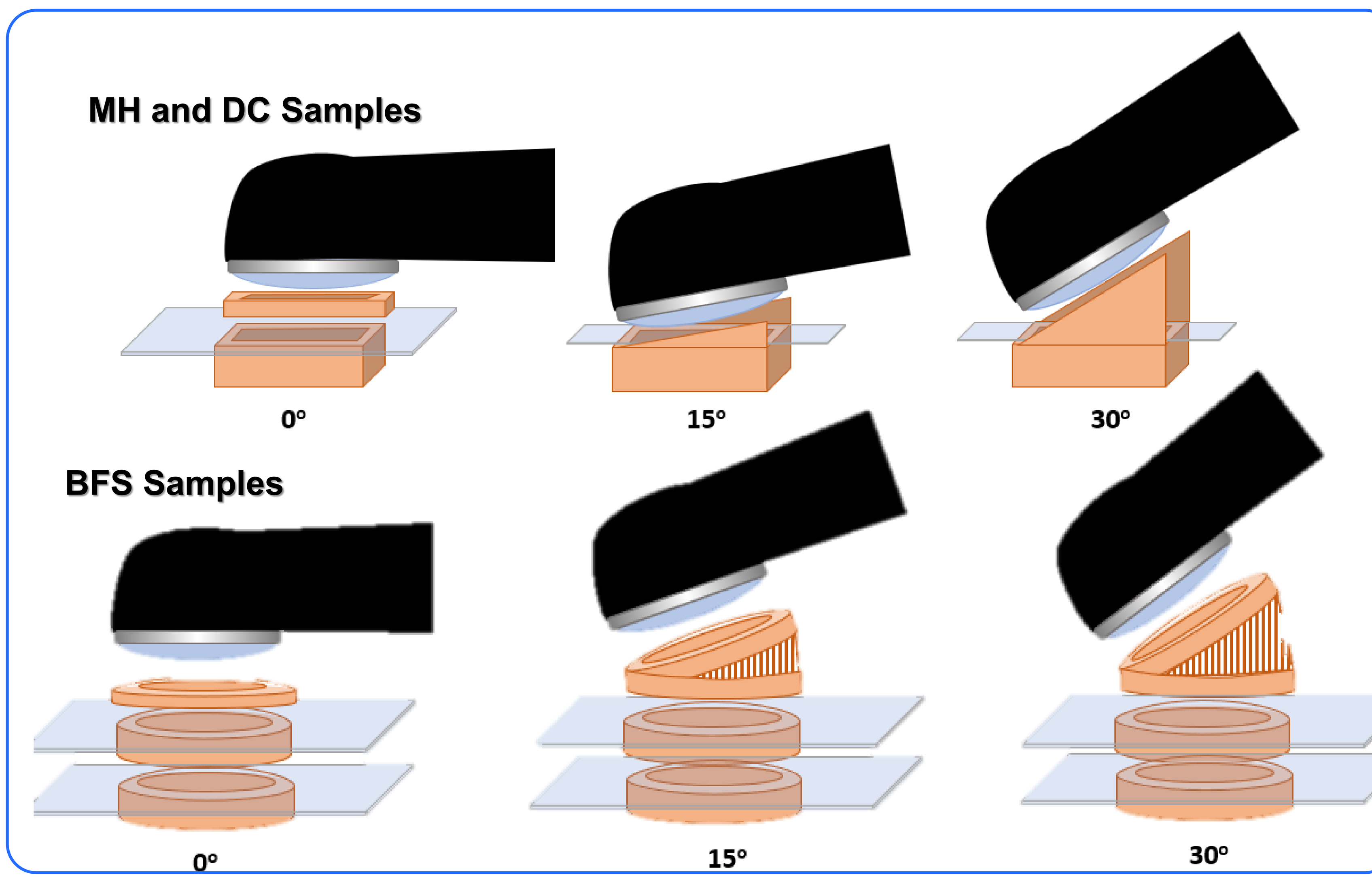
INTRODUCTION

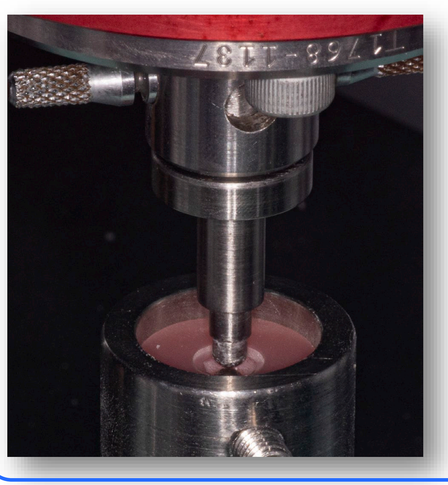
The inherent resin based composite's (RBC) polymerization shrinkage and the subsequent stress which occurs once the material has adhered to the tooth surface[1], may cause gaps formation at tooth/restoration interface, thus explaining why secondary caries lesions is one of the most common causes of composites restorations failure[2, 3]. To reduce the undesirable effects of contraction, advances in dentistry led to searching for materials that ease the restoration process. In 2006, the development of RBC for bulkfill technique were launched to the market[4], which offer to be placed in a single increment[5], reducing the restoration process time.

Despite having an innovative formulation, bulkfill composites keeps the polymeric essence of conventional RBC, so to achieve their maximum physical-mechanical properties they depend on proper handling during photopolymerization process. Inadequate light-curing influence the restorative material physical-mechanical properties, even more so in a material that is predestined to be used in the posterior sector, where the limited mouth opening makes it difficult to properly position the light-curing units, and may affect the quantity of light received by the restorative material, and therefore its physical-mechanical properties.

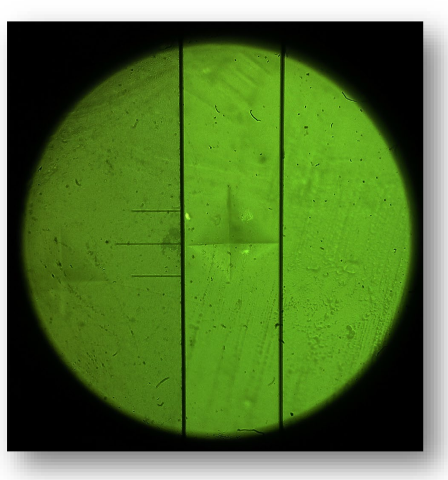
METHODS & MATERIALS

For MH and DC samples, 4 x 10 x 4mm quadrangular molds were 3D impressed and restored with Filtek One Bulkfill Restorative resin, 3M, A3 shade, positioning the curing lamp at 0°, 15° and 30° inclination separated by 1mm spacer. For BFS samples, two 3D Impressed discs (10 mm radius and 2mm thick) were stacked to get 4mm depth, and then were restored leaving a celluloid acetate band between each disc to be able to retrieve them later, then, the curing lamp were positioned at 0°, 15° and 30° inclination separated by 1mm spacer. The photopolymerization unit used for all specimen was a daily clinical use (not new) Valo (Ultradent) lamp in standard mode, delivering 875 mW/cm2 irradiance, whose was measured using the LM-1 radiometer from DTE, Guangxi, China



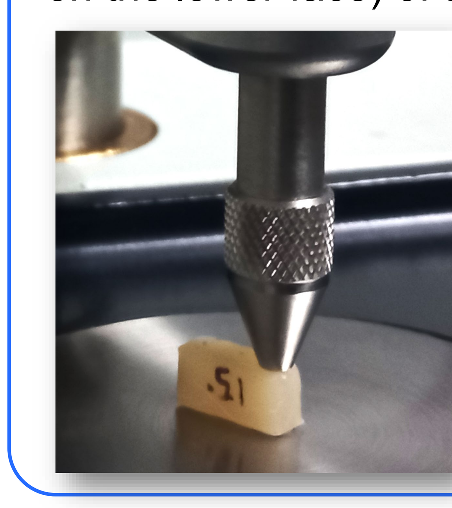


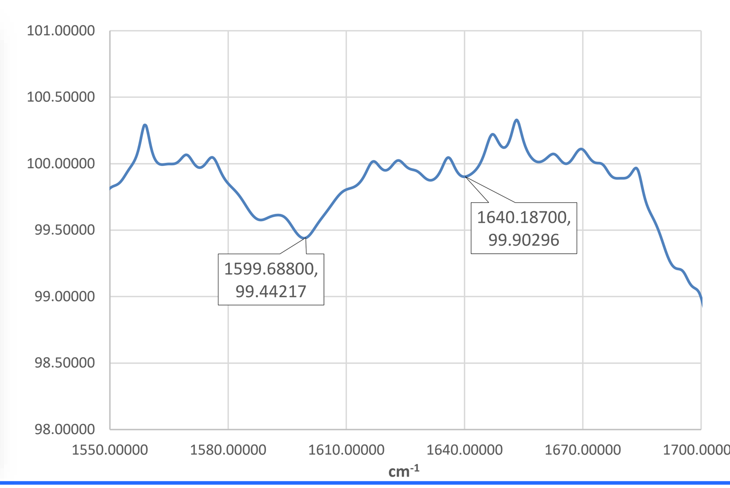
Instron Electropuls E3000 fatigue testing machine were used to perform BFS test (ball-on-three-balls) in 9 mm diameter by 2mm thickness discs, obtaining results in Mpa. The data of diameter and thickness of each disc, together with the resistance supported in Newtons, were recorded, to later apply the corresponding formula.

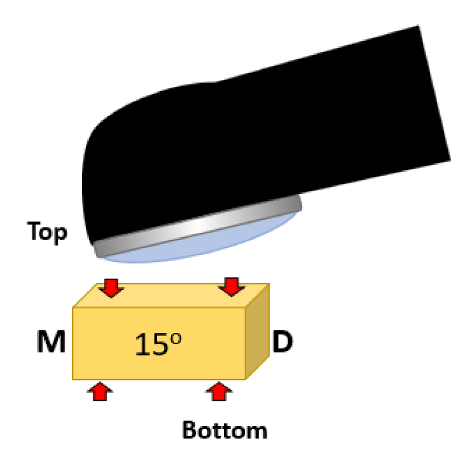


For MH test, the samples were analyzed in the Micromet 2001 durometer model 1600-4980 from Buehler®, implementing a Vickers hardness indenter. Three superficial indentations were made at 200 kg/force for 15 seconds in each of the four points of the sample: one in the portion closest to the light-curing unit (Mesial) and another in the distal portion of the sample (farthest from the unit), both on the most superficial side (Top) and on the deep (Bottom) side, indentations were measured and recorded in μm.

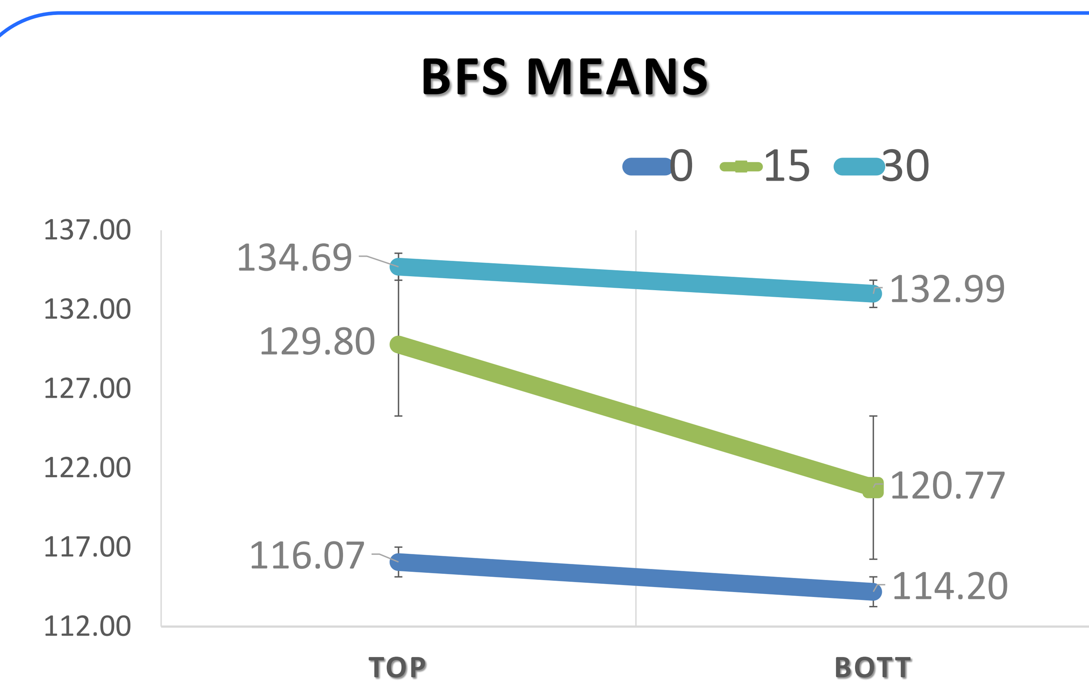
Furier infrared transmission spectroscopy with FT-IR Nicolet spectrometer, from Thermo electron corporation was carried out, where a portion of unpolymerized composite was tested obtaining a diagram that expresses the lengths corresponding to C=C bonds, then 4 readings (mesial and distal on the upper face and mesial and distal on the lower face) of the photopolymerized samples were carried out.

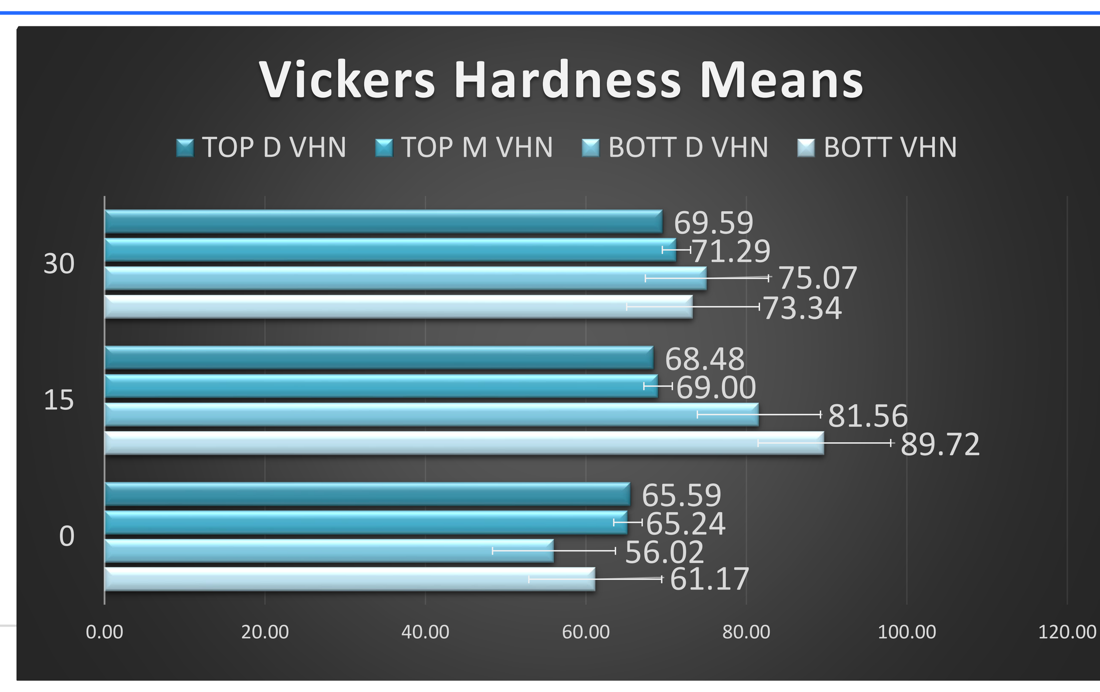


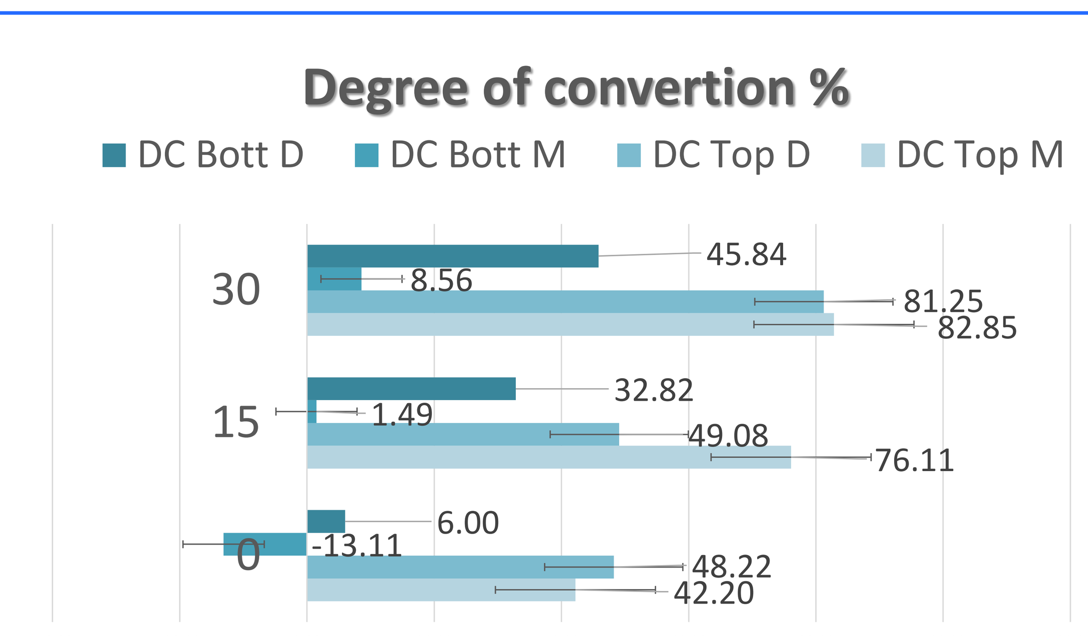




RESULTS







Regarding BFS, it was found statistically significant differences (p=0.011) between angulations, getting 30° group better values; this could be explained by assessing the fact that when tilting the photopolymerization unit, it's tip tends to separate from the surface giving the light beam opportunity to spread, therefore a bigger part of the material receives light., As to Top/Bottom BFS, Top surface was slightly superior (not statically significant p=0.401) than bottom, so it should be taken into account that the thickness of the increment continues to be an important consideration, in which the light-curing unit and its light penetration capacity plays a fundamental role.

There were MH statistically significant differences (p=0.001) between angulation an when comparing surface/angulation correlation (p=0.004) MH Values at the bottom were higher than top, the bulkfill composite modified inorganic phase, enhancing translucency[6, 7, 8, 9], therefore allowing good light penetration through the restorative material, could explain this findings, besides the implementation in this study of a well collimated photopolymerization unit (Valo, Ultradent).

The DC values in upper surface areas (Top) were statistically higher than that in the lower surfaces (bottom) with p=0000 specially in mesial portion, this could be explained taking into account that as long photopolymerization tip tilts, the preparation walls turn in to obstacles for light transmission, presenting shadows or "blind spots". Regarding angulation there was found statistically significant differences with p=0.033.

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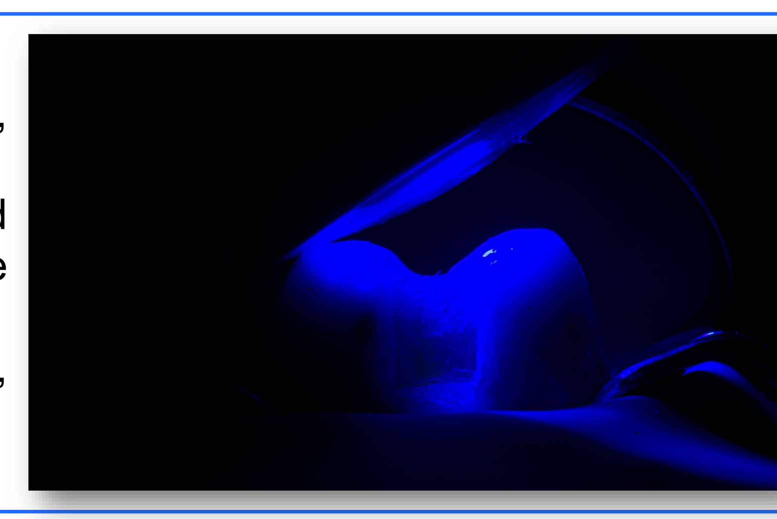
CONCLUSIONS

- According with the results of this work, the photopolymerization unit angulation affects bulkfill composites physicomechanical properties, mainly at the bottom of the restoration, since both MH and DC values were affected in all angulations.
- It must be taken in account the cavity configuration, in which shadows or areas without coverage of the light beam could be found because of the walls disposition, due to the dispersion that occurs as the light tilts, mainly affecting the internal or deepest part of the cavity preparation.
- An adequate Light-curing unit allows light to penetrate the deepest areas of the cavity preparation, so clinician should take into account, besides it's irradiance and power, it's design which allows to positioning accurately the tip in reduced space situation as in posterior teeth.



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