Afnan O Al-Zain et al., Dentistry 2018, Volume 8
DOI: 10.4172/2161-1122-C6-044

Influence of curing unit beam profile on polymerization patterns within a resin-matrix composite

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Statement of the Problem: Fracture failure of resin-matrix composite (RMC) increased in the past decade from 29.5%- 39.1% due to multiple factors that may include non-uniform polymerization across the RMC surface. Investigating polymerization patterns within the bulk of a RMC can contribute to greater understanding of fracture etiology.

Purpose: The purpose of this study was to investigate the relationship of an irradiance-beam-profile area from different light-emitting-diode (LED) curing-units on the degree of conversion (DC) and Knoop microhardness (KH) and cross-link density (CLD) uniformity within a RMC at two clinically relevant distances and explore the correlation among them.

Methodology: Irradiance-beam-profiles were generated from six light-curing units (LCUs); one quartz-tungsten-halogen, two single and three multiple-emission-peak LED units and combined with the corresponding power measurements. The radiant exposure was maintained, and a mapping approach was used to investigate DC (micro-Raman spectroscopy), KH (hardness tester) and %KH reduction as an indicator of CLD (ethanol-softening method) within a nano-hybrid RMC increment at various depths cured at two light-tip distances. The localized irradiance correlation with the corresponding DC, KH and %KH reduction was explored.

Findings: Non-uniform DC, KH and %KH reduction was observed within the specimens and localized polymerization discrepancies were significant at specific depths and points, which did not follow a specific pattern regardless of the LCU or curing distance. A mapping approach within the specimens provided detailed polymerization characterization. Localized irradiance was weakly correlated with the corresponding DC, KH and %KH reduction on the top RMC surfaces at both distances. Polymerization of the RMC investigated did not reflect the LCU irradiance pattern at the area assessed, and no LCU demonstrated uniform polymerization at all points for the measurements investigated at both distances. Therefore, the LCUs explored do not result in uniform polymerization, which may potentially increase the risk of RMC fracture.

Recent Publications:

1. Alqahtani S et al. (2017) Effect of multiple and single emission peak light emitting diode light curing units on the degree of conversion and microhardness of resin-based pit and fissure sealant. EC Dental Science. 14.3:157-166.
2. Al Zain A O et al. (2017) Degree of conversion and cross-link density within a resin-matrix composite. J. Biomed. Mater. Res. B Appl. Biomater. 106(4):1496-1504. Doi:10.1002/jbm.b.33960.
3. Al Shehri E et al. (2016) Effect of air-abrasion pressure on the resin bond strength to zirconia: a combined cyclic loading and thermocycling aging study. Restor. Dent. Endod. 42(3):206-215. Doi:10.5395/rde.2017.42.3.206.
4. Yassen G H et al. (2016) Evaluation of selected properties of a new root repair cement containing surface pre-reacted filled glass ionomer fillers. Clin. Oral. Investig. 20(8):2139-2148.
5. Feitosa S A (2015) Synthesis and characterization of novel halloysite-incorporated adhesive resins. J. Dent. 43(11):1316-22. Doi: 10.1016/j.jdent.2015.08.014.

Biography

Afnan O Al-Zain completed her BDS Degree from Faculty of Dentistry, King Abdulaziz University (KAU), Kingdom of Saudi Arabia; MSD Degree from Indiana University School of Dentistry, USA, and PhD Degree from Indiana University. She is an Assistant Professor in the Division of Operative and Esthetic Dentistry Faculty of Dentistry at KAU; is a Co-Course Director for third year BDS students. Her passion is to make an impact that would benefit society. Her research methodology creates new insight for understanding polymerization pattern to improving dental healthcare. She strives to contribute significantly to the direction of oral health care by engaging in research and dental education.

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