CED/NOF-IADR
2024 Oral Health
Research Congress
12 — 14 Sept 2024
Geneva, Switzerland

0146

New Understandings of the Complexities of Filler-Polymerisation Interrelationship

H. Haugen[2], S. Linskens[3], M. Par[1], V. Negovetic Mandic[1], Z. Tarle[1], A. Boccaccini[4], T. Tauböck[5], T. Attin[5], A. Gubler[5], S. Leeuwenburgh[3], M. Op de Beeck[6], Q. Ma[2], D. Marovic[1]
[1]Department of Endodontics and Restorative Dentistry, University of Zagreb School of Dental Medicine, Zagreb, Croatia, [2]Department of Biomaterials, Institute of Clinical Dentistry, University of Oslo, Oslo, Norway, [3]Department of Dentistry – Regenerative Biomaterials, Radboud University Medical Center, Nijmegen, Netherlands, [4]Department of Materials Science and Engineering, Institute of Biomaterials, University of Erlangen-Nuremberg, Erlangen, Germany, [5]Center for Dental Medicine, University of Zurich, Zurich, Switzerland, [6]Centre for Environmental and Climate Science, Lund University, Lund, Sweden

Objectives The variability of resin matrix and filler type, size and quantity can lead to inconclusive results when testing commercial composites. In this study, experimental nanohybrid composites with systematically varying filler content are used to investigate their effects on eleven polymerisation-related parameters. The functionality of novel methods, micro-CT and optical photothermal infrared spectroscopy (O-PTIR), is also evaluated.
Methods Five experimental dental composite materials were prepared with a Bis-GMA/TEGDMA resin matrix and increasing amounts of micro- and nanofillers (55-75 wt%). The degree of conversion was assessed using Fourier transform infrared spectroscopy (FTIR) and O-PTIR. Micro-CT was used to analyse volumetric shrinkage and a custom-designed linometer was used for linear shrinkage. The light transmission was measured with a MARC spectrometer. Spearman correlation analyses correlated the investigated parameters.
Results With increasing filler content, degree of conversion, maximum polymerisation rate, polymerisation shrinkage and maximum polymerisation rate decreased. The time to reach the maximum shrinkage rate was more than twice as long as the time to reach the maximum polymerisation rate. Volumetric shrinkage consistently showed higher mean values than linear shrinkage in most groups. Degree of conversion and volumetric shrinkage decreased with increasing depth of cure. The filler content had strong negative correlation with degree of conversion by FTIR (r_s=-.89, p<.001) and O-PTIR measurements at 2 mm depth (r_s=-.70, p<.001), volumetric (r_s=-.70, p<.001) and linear shrinkage (r_s=-.88, p<.001) as well as the maximum shrinkage rate (r_s=-.85, p<.001). Light transmittance correlated only moderately with the filler content (r_s=-.50, p=.005), and weak correlation was found between transmittance and other parameters.
Conclusions The intricate relationship between filler content and polymerisation-related parameters underlines the importance of studying their spatial and temporal evolution for the design and analysis of dental composite materials. The integration of micro-CT and O-PTIR techniques offers new insights into the polymerisation behaviour of composite materials.