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Dental microscope filters improving visibility during light-curing composite application

T. LANG*, A. D. HALVES, R. KENSMANN, B. JENNES and P. GAENGLER

ORMED - Institute for Oral Medicine at the University of Witten/Herdecke, Germany
eMail: info@ormed.net, web: www.ormed.net

Objectives:

Operating microscopes use bright light sources with a wide visible spectrum decreasing working time of light-curing restorative materials. Orange filters prevent unintended polymerization with less visibility of tooth structures and restorations. Therefore it was the aim of the study (i) to assess the prolongation of working time of light-curing composites by experimental filters (ii), to improve operating visibility with white light (CRI>80) and (iii) to compare with traditional orange filters.

Material and Methods:

Three experimental filters (GF1-3), the standard orange filter (GFZeiss) and unfiltered xenon light (20 klx) of Zeiss OPMI Pico microscope were used. Composite materials with different photoinitiators were tested (Charisma/shade A2, Venus Diamond/ A2: Heraeus, Hanau, Germany; GrandioSo/A2: Voco, Cuxhaven, Germany; Tetric EvoCeram Bulk Fill/IVB: Ivoclar Vivadent, Liechtenstein).

Polymerization over time was assessed every second with a vertical oscillating rheometer for each composite, each cycle was repeated 7 times. Prolongation factors for working time were defined at a viscosity level change of 50% and statistically analyzed using t-test and U-test. Photometrical analysis was provided for colour temperature and Colour-Rendering-Index (CRI).

Results:

The new light filters extended the working time significantly. Prolongation factors: no filter = 1, glass filter 1 = 1.7 - 2.6, glass filter 2 = 2.5 - 4, Glass filter 3 = 1.2 - 1.8. The working time varied depending on the composite formulation. The orange filter allowed unlimited working time.

Effect on light and colour conditions: the colour reproduction of the orange filter GFZeiss was poor due to the monochromatic light. The photometric analysis revealed the CRI for Xenon light > 90, for glass filter GF 1 = 88.1, for glass filter GF 2 = 88.6, for glass filter GF 3 = 89, for the orange filter GF Zeiss = out of range. Colour temperature was for Xenon: 6000 K, for GF 1 = 3834 K, for GF 2 = 3778 K, for GF 3 = 2556 K and for the orange filter GF Zeiss = 2541 K. GF 1 and GF 2 provided neutral white light colour with a good colour reproduction superior to the xenon light source.

Conclusions:

All three experimental glass filters prolonged the working time of dental restorative composite materials to a clinically acceptable level. The Colour Rendering Index (CRI) was improved to the value of neutral white light (GF1 and GF2) and warm white (GF3) providing clinically optimal distinction of different tooth structures and composite colours.

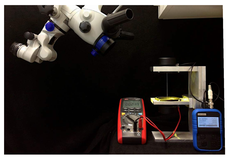

Fig. 1: Test setup: operating microscope with oscillating rheometer

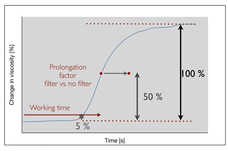

Fig. 2: Parameters to define end of working time by rheological measurements

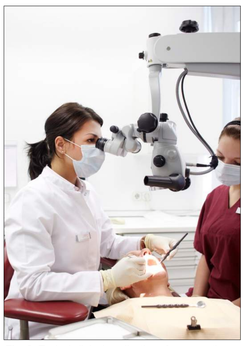

Fig. 3: Typical clinical application of an operating microscope

Fig. 4: OF: unfiltered Xenon Light. GF Zeiss: original orange filter by Zeiss. GF1-GF3: different test filter variants. XY: Positions of the test filters in the CIE 1931 colour space

Type of light	CRI	Colour tempereature Kelvin
OF (unfiltered Xenon)	>90	6000 K
GF Zeiss (original orange filter)	out of range	2541 K
GF1	88.1	3834 K
GF2	88.6	3778 K
GF3	89	2556 K

Tab. 1: Measured CRI values and colour temperature of the tested light conditions

Name	Charisma	GrandioSo	Tetric EvoCeram Bulk Fill	Venus Diamond
Type	Ultra-fine particle hybrid	Nanohybrid	Nanohybrid	Nanohybrid
Colour	A2	A2	IVB	A2
Organic Matrix	BisGMA TEGDMA	BisGMA BisEMA TEGDMA	BisGMA BisEMA UDMA	TCD-di-HEA UDMA
Filler Content	61 Vol.-%	73 Vol.-%	61 Vol.-%	64 Vol.-%
Photoinitiator-System	CQ/Amin Irgacure 819	CQ/Amin	CQ/Amin Lucirin TPO Ivocerin	CQ/Amin Lucirin TPO PPD

Tab. 2: Differences in the composition of the tested composite materials

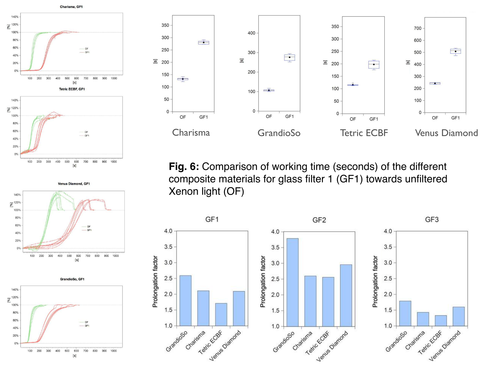

Fig. 6: Comparison of working time (seconds) of the different composite materials for glass filter 1 (GF1) towards unfiltered Xenon light (OF)

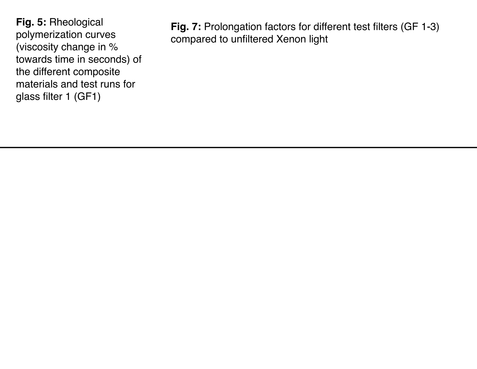

Fig. 7: Prolongation factors for different test filters (GF 1-3) compared to unfiltered Xenon light

Fig. 5: Rheological polymerization curves (viscosity change in % towards time in seconds) of the different composite materials and test runs for glass filter 1 (GF1)