Dental microscope light improves visibility during light-curing composite application

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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 different experimental LED light-sources and (ii) to improve operating visibility with white light compared with traditional orange light.

Material and Methods:

Three experimental light modes (5500 K, Orange, Experimental), used by a experimental ZEISS OPMI microscope, were calibrated to similar intensity of 15 klx. Four 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/IV B: Ivoclar Vivadent, Liechtenstein).
Polymerisation over time was assessed second by second with a vertically oscillating rheometer for each composite, each cycle was repeated 7 times (n=7) and statistically analyzed using t-test.
Photometrical analysis was provided for color temperature and Color-Rendering-Index. 3D-color differentiation (Vita 3D-Master, Bad Säckingen, Germany) was performed by two observers.
The microscopic differentiation was tested by two observers in 7 teeth with carious lesions, 7 teeth with periodontitis, 7 teeth with visible root transparence (old teeth) and 7 healthy teeth without visible root transparency (young healthy teeth).

Results:

Experimental light mode extended the working time significantly ($p<0.001$). The means of working time varied between tested composite materials: 5500 K= 72-148 s; Experimental= 168-323 s; Orange= 939-1690 s, depending on different composite formulations.
Effect on color differentiation was excellent for Experimental and 5500 K mode. With Orange mode color differentiation was inadequate.
Photometric analysis: CRI values were 88 in 5500 K mode, 79 in Experimental mode and 65 in Orange mode. The Color temperature was 5555 K in 5500 K mode, 3740 K in Experimental mode and 2242 K in Orange mode.

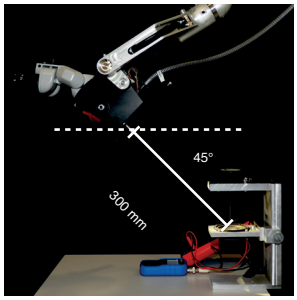
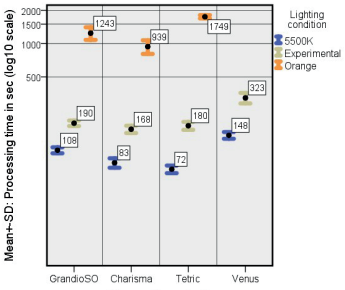


Fig. 1: Laboratory set up with Zeiss microscope prototype angulated to the oscillating rheometer.

Fig. 2: ZEISS EXTARO 300 featuring a LED light source optimally adapted for dental applications.



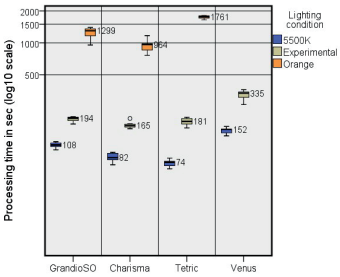


Fig. 4: Error bars and boxplots of processing time for lighting conditions and different Composite materials.

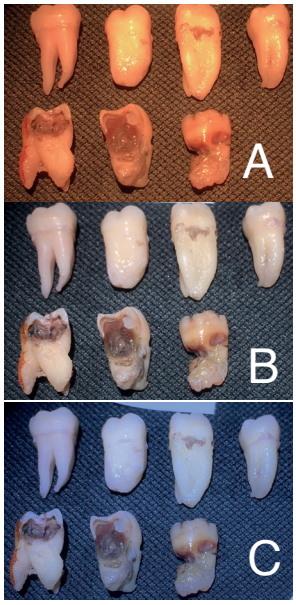


Fig. 3: Example for tested carious teeth: A: Orange mode; B: Experimental mode; C: 5500K mode.

Fig. 5: Mean equality test/ t-Test of processing time: Multiple group contrasts for lighting condition and composite material. All lighting conditions demonstrate highly significant differences of increased working time compared to the Orange mode and to the 5500 K mode.

Factor	Group contrast	t-Test			
		t	df	p	Difference of means
Lighting condition	5500K vs. Experimental	-8,117***	37,817	0,000	-112,43
	5500K vs. Orange	-15,581***	20,230	0,000	-1187,58
	Experimental vs. Orange	-13,956***	21,102	0,000	-1075,15
Composite material	GrandioSO vs. Charisma	,912	49,998	0,366	102,11
	GrandioSO vs. Tetric	-,771	48,658	0,444	-119,64
	GrandioSO vs. Venus	1,458	33,300	0,154	138,51
	Charisma vs. Tetric	-1,548	41,052	0,129	-221,75
	Charisma vs. Venus	,492	37,820	0,626	36,40
	Tetric vs. Venus	1,980[b]	30,246	0,057	258,15

Conclusions:

In contrast to the Orange mode, the Experimental mode inhibits the premature polymerization of light curing composite restorative dental materials with contemporary photoinitiators. The resulting clinical application time of restorations allows, in contrast to the standard 5500 K light settings, complex restoration techniques including incremental application, individual color matching and forming of age-dependent smooth and masticatory tooth surfaces at incisors, canines, premolars and molars.
In contrast to Orange mode, the Experimental mode fulfills the most important clinical requirements of optimal color differentiation of dental hard tissues in health and disease.
Therefore, the optimally adapted LED light source contributes to the precise discrimination of residual caries, dentin infractions and morphological irregularities.