Effect of composite shade on temperature change during photopolymerization

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I. Objective

The aim of this study was to investigate the temperature change during composite photopolymerization according to the composite shades.

II. Methods

Each 0.37 g of conventional nanocomposite (Filtek Z350XT Universal Restorative; A2 enamel (Z3E), A2 body (Z3B) or A2 dentin (Z3D) shades, 3M ESPE, St. Paul, MN, USA) was pressed between two glass slides with a 1-mm-thick spacer. A disk-shaped specimen was prepared and photopolymerized for 20 s with a radiant emittance of 2,100 mW/cm^2. The temperature change was measured using a non-contact infrared thermometer for 300 s (n=3). A second light exposure, using the same protocol as the first, was performed on each photopolymerized specimen. The first temperature peak (ΔT_{total}) and the second peak (ΔT_{light}) caused by a light curing unit were obtained from the temperature change vs. time curve. The net temperature change ($\Delta T_{composite}$) caused by the curing heat of the composite was acquired by subtracting the second curve from the first. The peak time was defined as the time when the $\Delta T_{composite}$ occurred. The CIE L*, a*, and b* values of each specimen were measured using a spectrophotometer without background, and then, with a white or black background, to calculate the translucency parameter (TP).

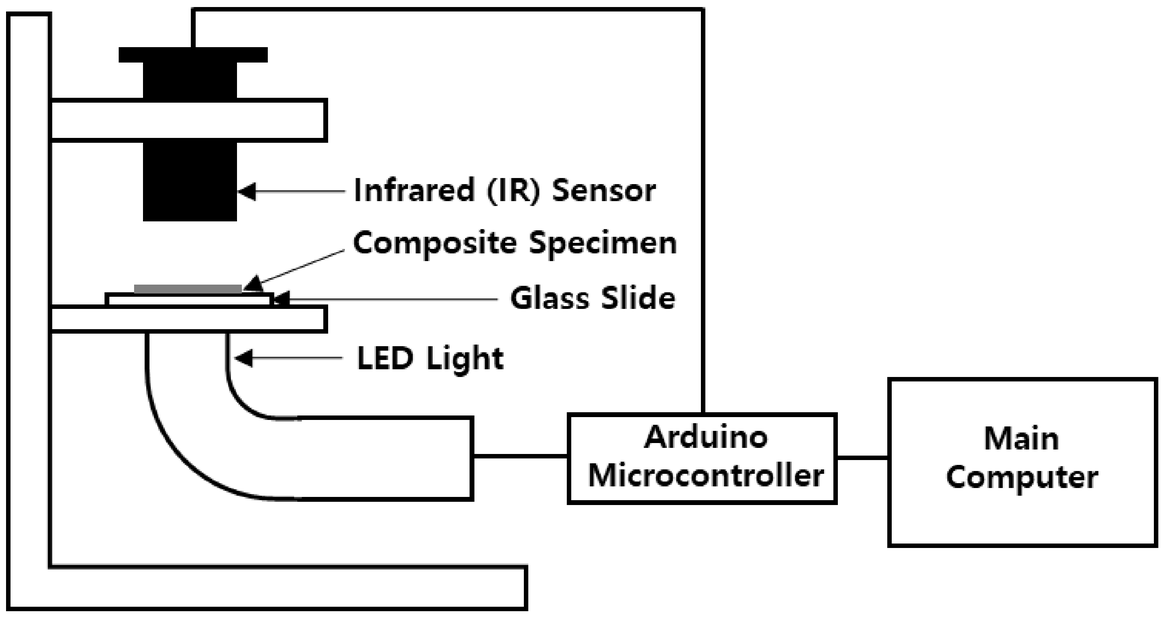

Fig. 1. Schematic diagram of the non-contact infrared thermometer.

III. Results

The ΔT_{total} and ΔT_{light} of Z3D (31.93℃ and 22.07℃) was the highest followed by Z3B (27.74℃ and 17.19℃), while Z3E (23.94℃ and 14.15℃) showed the lowest ΔT_{total} and ΔT_{light} ($p<0.05$). The peak time of Z3D (4.07 s) was longer than that of Z3B (3.28 s) ($p<0.05$). The ΔT_{total} and ΔT_{light} increased as L* increased, b* increased, and TP decreased. The $\Delta T_{composite}$ did not correlate with L*, a*, b*, or TP.

Table 1. Temperature rise and peak time (the time when maximum temperature rise by the curing heat of composite, $\Delta T_{composite}$, occurs) with different composite shade

Composite	Temperature Rise (℃)			Peak Time (s)
	ΔT_{total}	ΔT_{light}	$\Delta T_{composite}$	
Z3E	23.94 (0.50) ^{c}	14.15 (0.20) ^{c}	12.14 (0.15) ^{a,b}	3.42 (0.35) ^{a,b}
Z3B	27.74 (0.75) ^{b}	17.19 (0.42) ^{b}	13.16 (0.51) ^{a}	3.28 (0.31) ^{b}
Z3D	31.93 (0.55) ^{a}	22.07 (1.03) ^{a}	11.39 (0.57) ^{b}	4.07 (0.19) ^{a}

Standard deviations are shown in parentheses.
Different superscript letters indicate significant differences among composites in the same column ($p<0.05$).

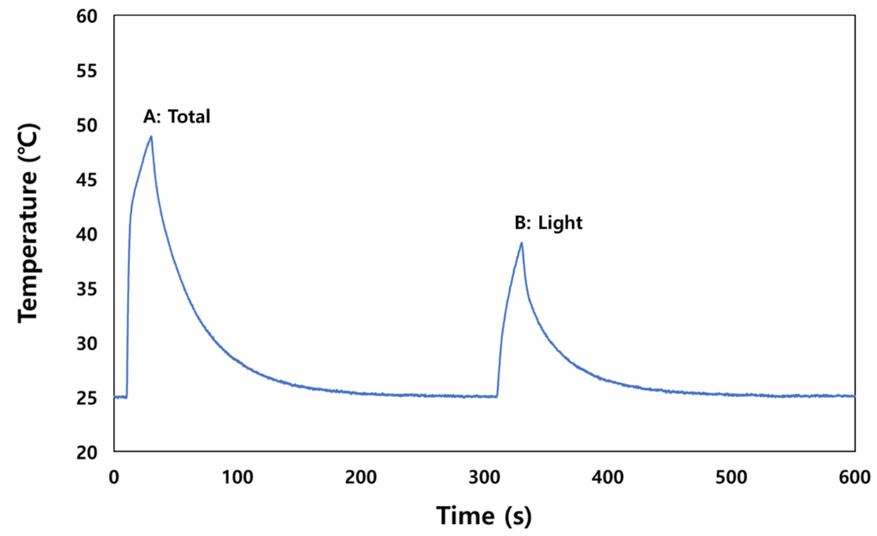

Fig. 2. Representative curve of temperature change *vs.* time of Z3E composite during photopolymerization. (A: Total temperature change caused by the heat from the first light exposure and composite polymerization, B: Temperature change caused by only the second successive light exposure on the polymerized composite).

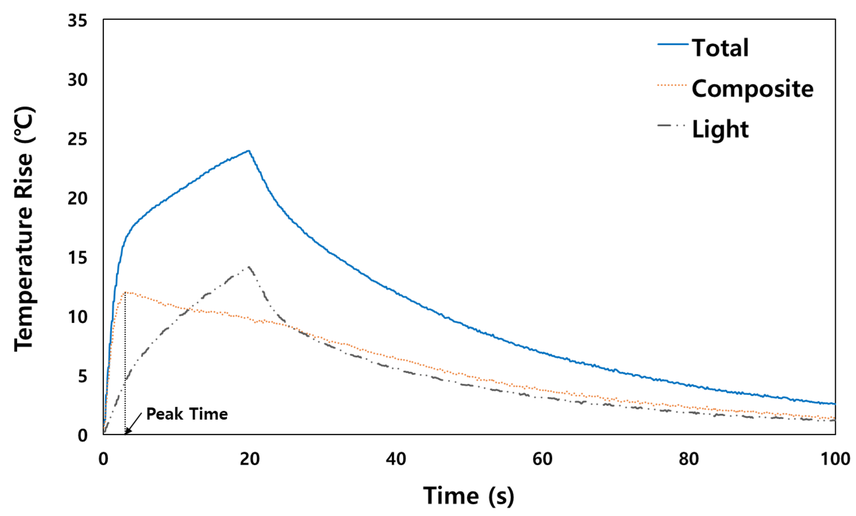

Fig. 3. Representative temperature rise curves in total, caused by the heat of polymerization of the composite, and caused by the LED light in Z3E composite.

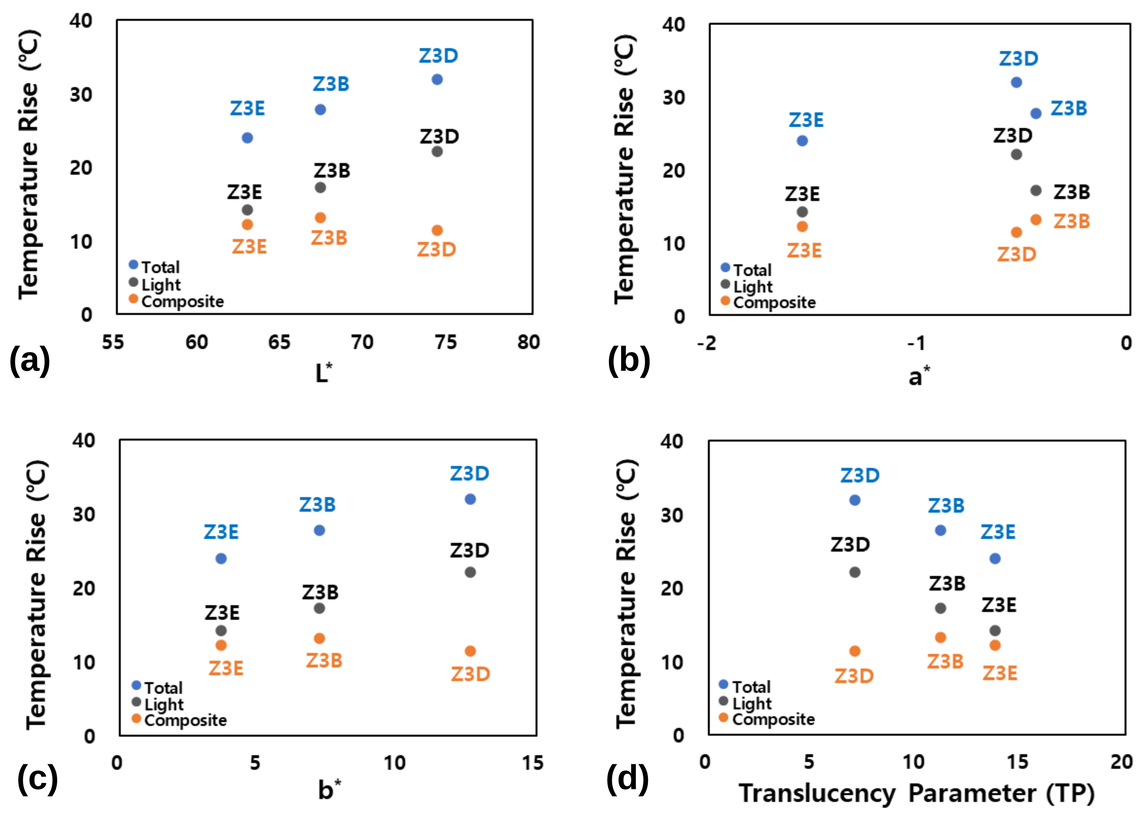

Fig. 4. Correlations between temperature rise and (a) L*, (b) a*, (c) b*, and (d) TP of composites.

IV. Conclusion

Significant differences in temperature change were observed during composite photopolymerization among different shades. The more opaque the composite was, the greater the increase in ΔT_{total} and ΔT_{light}.

V. Conflict of Interests

The authors certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this research.