学術情報

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Evaluation of translucency for a new clear silicone material

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Objectives

When clear silicone material is used as a clear matrix for curing restorative composite resin,
there is a possible issue that the composite resin's depth of cure is decreased .
This may be due to curing light going through clear silicone materials that are not completely transparent.
Also distance between resin and light curing unit is increased resulting in less light energy reaching target.
The aim of this study was to evaluate the translucency and effect for depth of cure
of a newly developed clear silicone material.

Fig.1 EXACEAR

Methods

Preparation

1. Materials
   Three clear silicone materials shown in Table.1 were examined.
2. Fabrication the silicone disk
   Fill clear silicone material into metal ring (25 mm diameter and 8 mm or 18 mm height)
   and cure according to instruction from manufacture.

Table.1 Materials

Clear silicone material		
Material	Manufacturers	Lot No.
EXACLEAR	GC America	1401302G
MEMOSIL2	Heraeus	395072
glassbite	DETAX	170801
Composite resin		
Material	Manufacturers	Lot No.
G-aenial Universal Flo A3	GC America	1412251

Property comparison of clear silicone materials

3. Total light transmittance (T.T.) and HAZE for the siliconedisk
   Total light transmittance (T.T) and HAZE for each silicone disk is measured
   by HAZE METER (NIPPON DENSHOKU, NDH-5000).
4. Depth of cure for composite resin through silicone disk
   Depth of cure testing is based upon "ISO4049:2009 7.10 Depth of cure, Class 2 materials".
   Composite resin (GC Corp., G-aenial Universal Flo A3) was filld into the stainless steel mold.
   Silicone disk is put on the stainless steel mold. Irradiated curing light thourgh silicone disk
   and measure depth of cure through silicone disk. (N=5) (Fig.2)
   Results were statistically analyzed. (ANOVA, Tukey's $p<0.05$)
5. Light intensity of transmitted light throurgh silicone disk
   Light intensity of transmitted curing light (GC Corp., G-Light Prima, 1200mW/cm2, 10 seconds mode)
   through each silicone disk was measured
   by light intensity meter (MELLES GRIOT, 30W BROADBAND POWER/ENERGY METER). (N=5)
   Results were statistically analyzed. (ANOVA, Tukey's $p<0.05$)

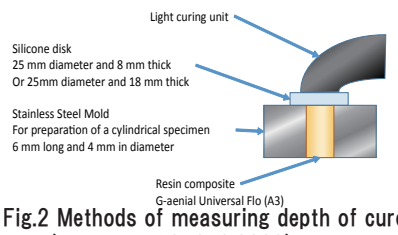

Fig.2 Methods of measuring depth of cure
(based on ISO4049:2009)

Analysis of light transmission characteristics of EXACLEAR

6. Visualize transmitted light distribution on cured composite resin
   Composite resin (GC Corp., G-aenial Universal Flo A3) was filled into metal ring (24mm diameter and 8mm height)
   and cured by curing unit (GC Corp., G-Light Prima, 1200mW/cm2, for 10 seconds) through silicone disk.
   Curing condition [distance between curing unit and surface of composite resin :0mm, 8mm air, 8mm EXACLEAR]
   Shape of cured composite resin was measured by 3D Measurement Macroscope (KEYENCE, VR-3100). (Fig.3)

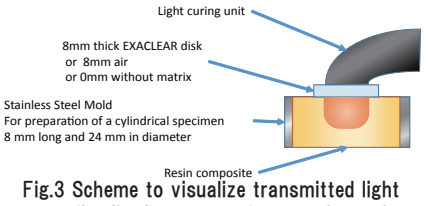

Fig.3 Scheme to visualize transmitted light
distribution on cured composite resin

Results

Results1 "Comparing of clear silicone materials"

- Value of T.T of EXACLEAR is higher than other 2 materials,
  and Value of HAZE of EXACLEAR is lower than other 2materials,
  because EXACLEAR does not contain the component
  that influences refraction of the light.(Table.2)
- EXACLEAR has higher transparency and at visual observation,
  transmitted light through the silicone disk was straight without spreading.(Fig.4,5)

Table.2 Values of T.T and HAZE of silicone materials

	EXACLEAR		MEMOSIL2		glassbite	
Silicone disk thickness	8mm	18mm	8mm	18mm	8mm	18mm
T.T	92.42	89.15	58.36	31.17	54.5	24.96
HAZE	6.05	17.87	36.65	57.3	60.02	84.25

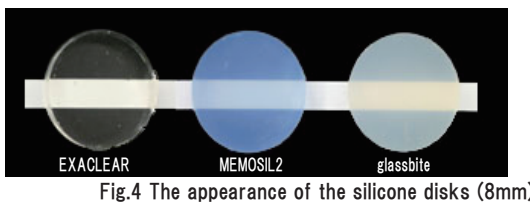

Fig.4 The appearance of the silicone disks (8mm)

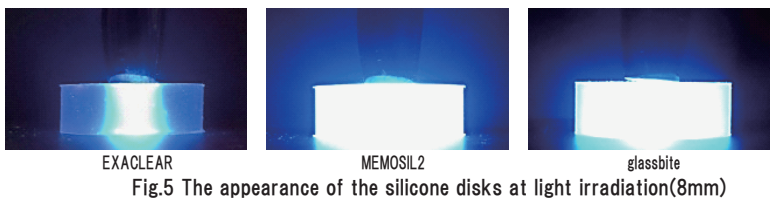

Fig.5 The appearance of the silicone disks at light irradiation(8mm)

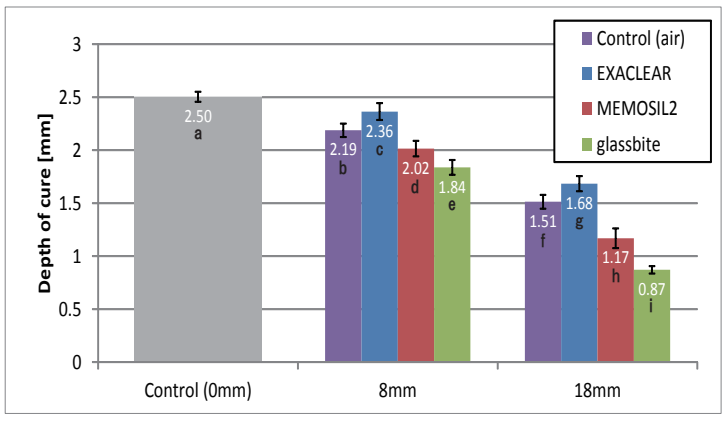

Fig.6 Depth of cure of composite resin with or without the silicone disks
Same superscript means no significant different ($P<0.05$)

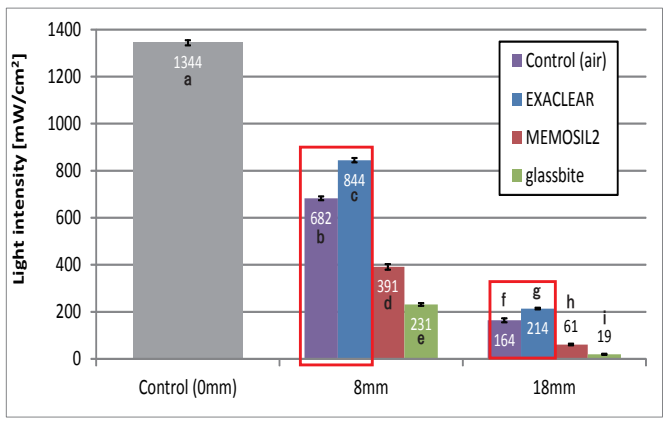

Fig.7 Light intensity with or without silicone disks
Same superscript means no significant different ($P<0.05$)

- Results were shown EXACLEAR has higher permeability of the curing light and made deeper depth of cure of composite resin.(Fig.6,7)
- There was a strong correlation between light intensity and depth of cure. ($R^2=0.9764$)

Results2 "Light transmission characteristics of EXACLEAR"

The light reaching light intensity meter
through EXACLEAR silicone disk was stronger
than without silicone disk. (Air) (Fig.7 red frame)
This suggests that EXACLEAR has a property
to transfer produced light without weakening.

- On cured composite resin with 8mm air,
  shape was wider and thinner than control. (Flg.9)
- On cured composite resin with 8mm EXACLEAR,
  shape was thick and narrow
  which is similar to control. (Flg.9)
- Larger difference of refractive index between
  medium makes for larger refraction of transmitted light.
  →Refractive index difference compared with glass fiber
  of curing unit. Air > EXACLEAR (Table.3)
- An expansion of light is reduced with transferring light
  through EXACLEAR.
  →Even if distance unchanged,
  it efficiently deliver curing light to composit resin. (Fig.10)
- EXACLEAR worked like extension of the glass fiber of curing unit.

Fig.8 The shape of cured composite resin with EXACLEAR, air or none

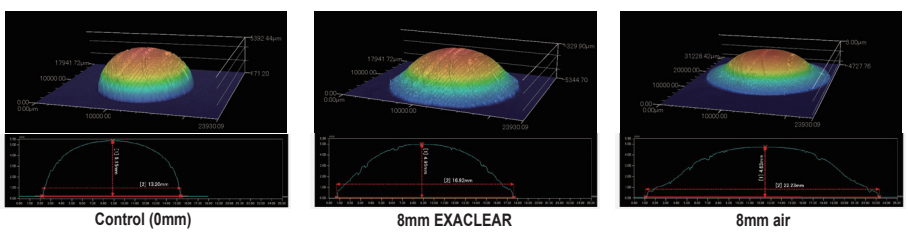

Fig.9 The result of measuring shape of cured composite resin with EXACLEAR, air or none

Table.3 Refractive index of materials

Material	Refractive index	Difference of refractive index between each materials and glass fiber
Glass fiber (Reference data)	1.4585	–
EXACLEAR	1.431	0.0275
MEMOSIL2	1.408	0.0505
glassbite	1.417	0.0415
Air (Room temperature) (Reference data)	1.00028	0.45822

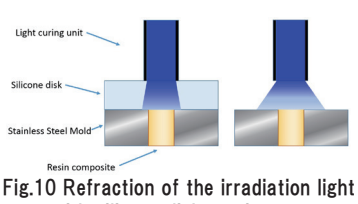

Fig.10 Refraction of the irradiation light
with silicone disk or air

Conclusions

Based on this study,
1.EXACLEAR is the more transparent of those tested.
2.EXACLEAR works like the extention of the fiber rod of light curing unit.
3.Diffusion of light through EXACLEAR was smaller, and amount of light reaching composite resin was larger.
4.EXACLEAR is suitable as clear matrix material for curing restorative composite resins.