

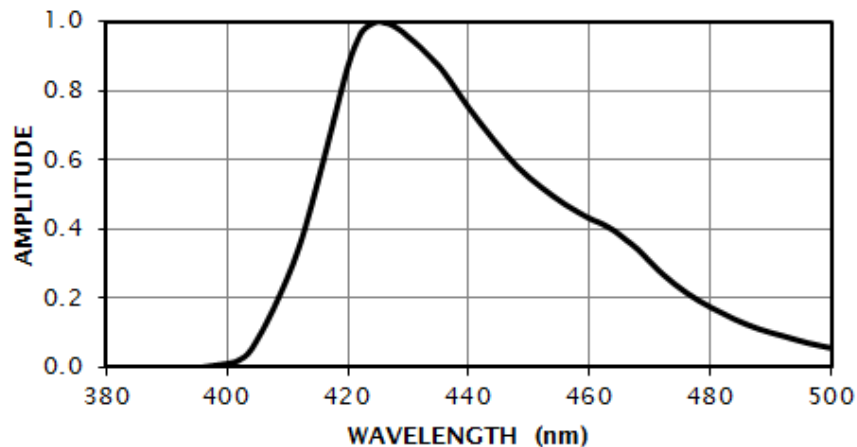
Optical Coupling Material Study

Scintillator & Photomultiplier

■ EJ-200 (ELJEN TECHNOLOGY)

PROPERTIES	EJ-200	EJ-204	EJ-208	EJ-212
Light Output (% Anthracene)	64	68	60	65
Scintillation Efficiency (photons/1 MeV e ⁻)	10,000	10,400	9,200	10,000
Wavelength of Maximum Emission (nm)	425	408	435	423
Light Attenuation Length (cm)	380	160	400	250
Rise Time (ns)	0.9	0.7	1.0	0.9
Decay Time (ns)	2.1	1.8	3.3	2.4
Pulse Width, FWHM (ns)	2.5	2.2	4.2	2.7
H Atoms per cm ³ (×10 ²²)	5.17	5.15	5.17	5.17
C Atoms per cm ³ (×10 ²²)	4.69	4.68	4.69	4.69
Electrons per cm ³ (×10 ²³)	3.33	3.33	3.33	3.33
Density (g/cm ³)	1.023	1.023	1.023	1.023
Polymer Base	Polyvinyltoluene			
Refractive Index	1.58			

EJ-200 EMISSION SPECTRUM



■ H7195 (HAMAMATSU)

Assembly Size	Dia.60 mm
PMT Tube Size	51 (2) mm
Built-in PMT Type No.	R329-02
Photocathode Area Shape	Round
Photocathode Area Size	Dia.46 mm
Wavelength (Short)	300 nm
Wavelength (Long)	650 nm
Wavelength (Peak)	420 nm
Spectral Response Curve Code	400K
Photocathode Material	Bialkali
Window Material	Borosilicate glass
Dynode Structure	Linear-focused
Dynode Stages	12

Optical Coupling Material Study

Optical Coupling Materials

	Material Type	Manufacturer	Refractive Index	Linear Shrinkage	Viscosity [cP]
TSK-5353 (OKEN-6262A)	Silicone Optical Grease	Momentive, Japan	1.453		
BC-600 (EJ-500)	Optical Cement	Saint-Gobain, France	1.56 (1.57)		800 cps
BC-630 (EJ-550)	Silicone Optical Grease	Saint-Gobain, France	1.465 (1.46)		
BC-634A (EJ-560)	Optical Interface Pad (Silicone Rubber Optical Interface)	Saint-Gobain, France	1.42 (1.43)	-	-
3094	UV-glue (Low-Stress Plastic Bonder)	Dymax, USA	1.5	0.2%	Liquid-Gel (1,000 cP)
OP-4-20632 *	UV-glue (Optical Assembly Adhesive)	Dymax, USA	1.55	0.39%	Liquid (480 cP)
OP-4-20632-GEL	UV-glue (Optical Assembly Adhesive)	Dymax, USA	1.55	1.1%	Gel (57,500 cP)
OP-24-REV-B	UV-glue (Optical Assembly Adhesive)	Dymax, USA	1.50	0.39%	Liquid (800 cP)
OP-29 *	UV-glue (Optical Assembly Adhesive)	Dymax, USA	1.50	0.79%	Liquid (2,500 cP)
OP-29-GEL *	UV-glue (Optical Assembly Adhesive)	Dymax, USA	1.50	0.79%	Gel (20,000 cP)

Scintillator EJ-200 (Polyvinyltoluene)

Optical glass (Borosilicate)

▪ Wavelength of Maximum Emission = 425 nm

▪ Refractive Index = 1.52

▪ Refractive Index = 1.58

* resist yellowing

상기 dymax 제품들은 모두 PVT 및 borosilicate 접착에 적합한 제품들임

Optical Coupling Material Study

Dymax 견적

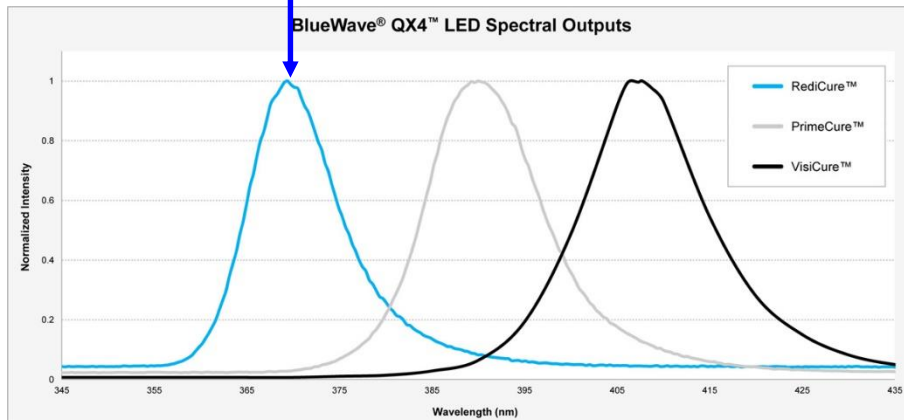
단위: 원

품번/명	개요	용량	단가	수량	금액
3094		10 ml	29,000	10	290,000
4-20418		10 ml	39,000	10	390,000
OP-4-20632		10 ml	74,000	10	740,000
OP-4-20632-Gel		10 ml	74,000	10	740,000
OP-24-REV-B		10 ml	31,000	10	310,000
OP-29		10 ml	31,000	10	310,000
1405-M-T-UR-SC		10 ml	41,000	10	410,000
41571/41552	QX4 LED Spot Cure System with 365nm Redicure	set	2,400,000	1	2,400,000
40322/5720	BlueWave LED Prime UVA Spot Cure System with Lightguide(1px5mmx1m)	set	4,700,000	1	4,700,000

단위: 원

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3094		10 ml	29,000	10	290,000
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OP-24-REV-B		10 ml	31,000	10	310,000
OP-29		10 ml	31,000	10	310,000
1405-M-T-UR-SC		10 ml	41,000	10	410,000
38903/5720	BlueWave 200 UV Spot Cure System with LightGuide	set	7,900,000	1	7,900,000

Dymax Curing System

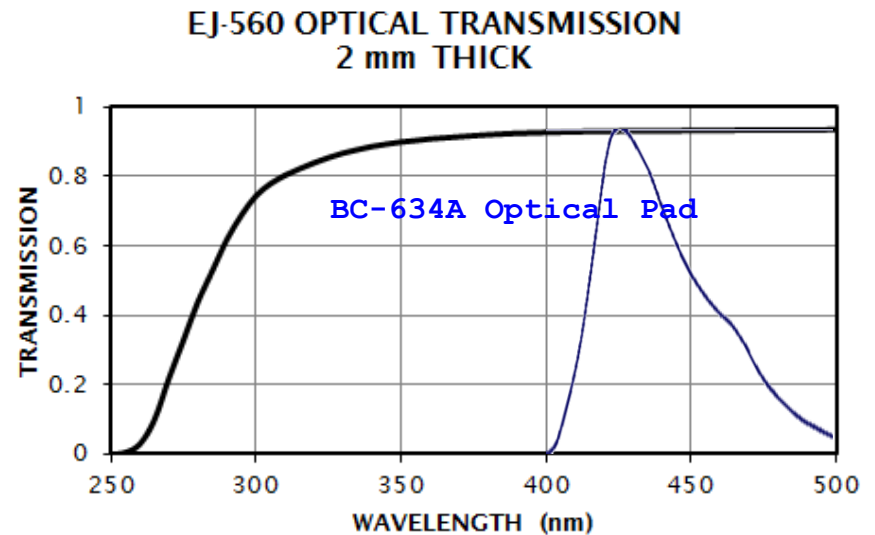
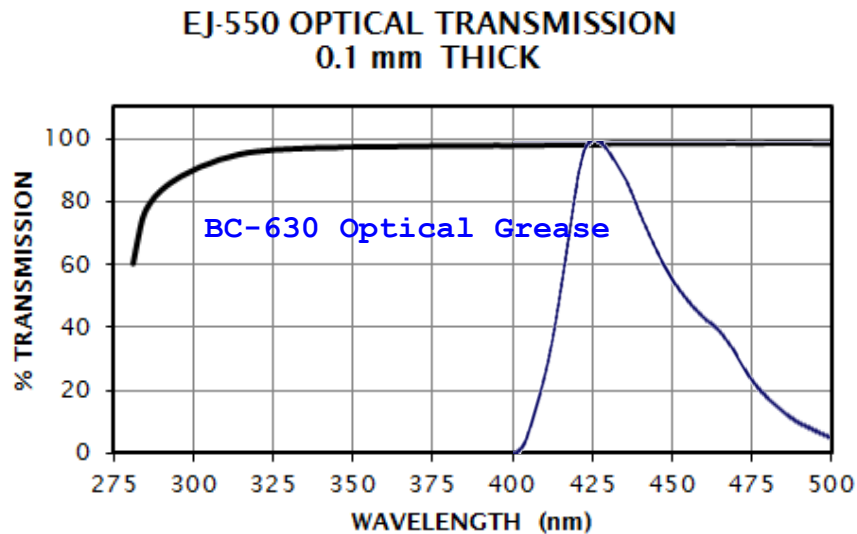
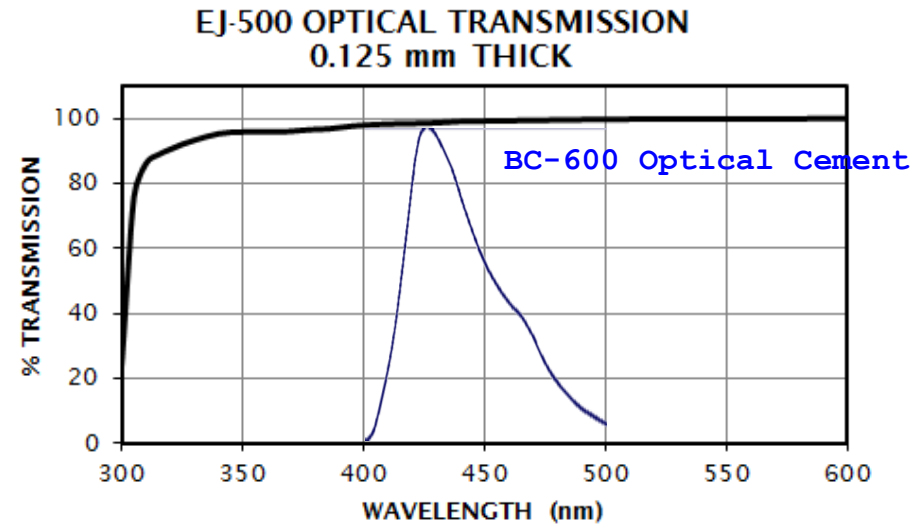
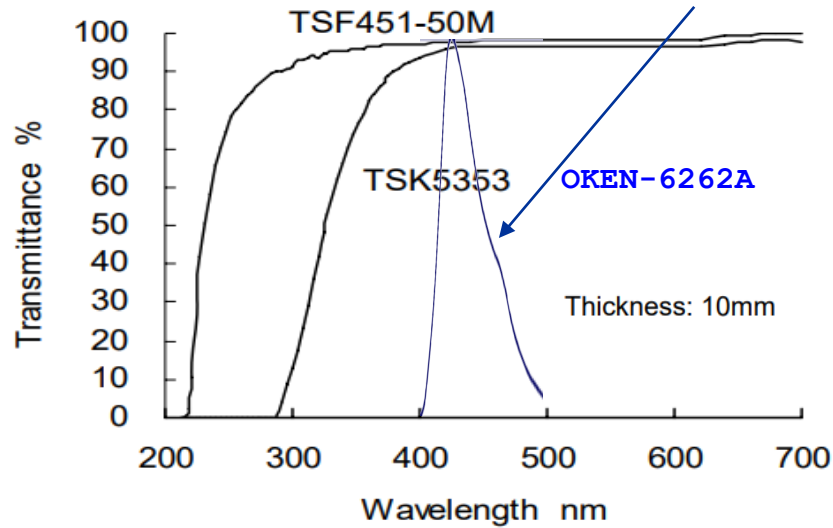


- Dymax BlueWave QX4 LED Spot-Curing System
 - Output Frequency : 365 nm
 - Intensity Output : 7,430 mW/cm² @ 5 mm
1,191 mW/cm² @ 25 mm
 - Price : 2,400,000 원 (1 channel)
 - 몇가지 검토 후 결정 예정 (scintillator를 통해 LED를 조사해야 하므로 경화시간 등을 계산해 봐야함)
- BlueWave 200 (최상위모델)
 - Output Frequency : 280 – 450 nm
 - Intensity Output : > 17,000 mW/cm²
 - Price : 7,900,000 원
- BlueWave LED Prime (중간모델)
 - Output Frequency : 380 nm
 - Intensity Output : > 15,000 mW/cm²
 - Price : 4,700,000 원
- output frequency, intensity 외에는 cooling system 등의 차이만 있음.

Optical Coupling Material Study

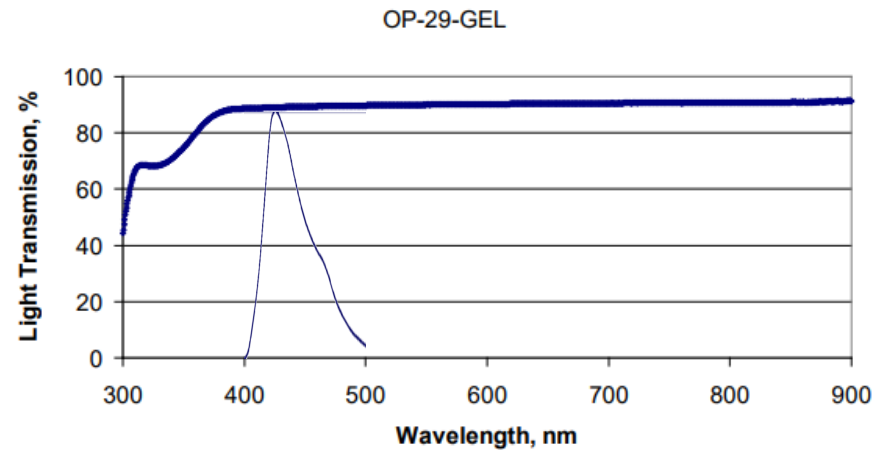
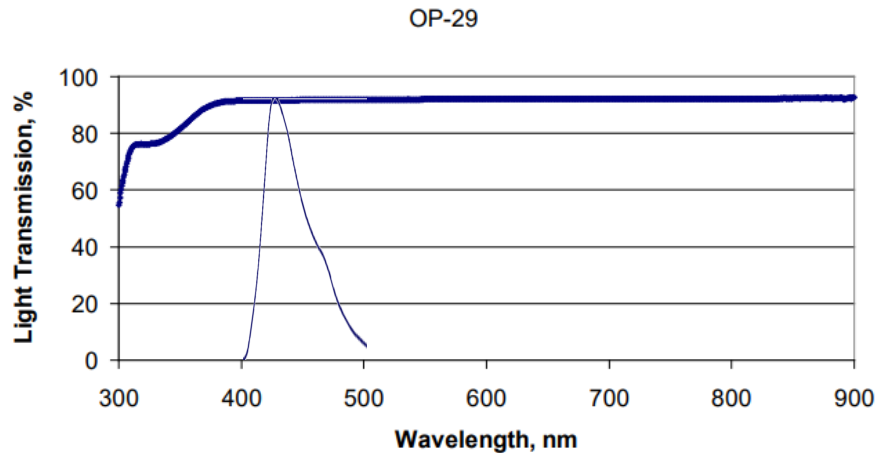
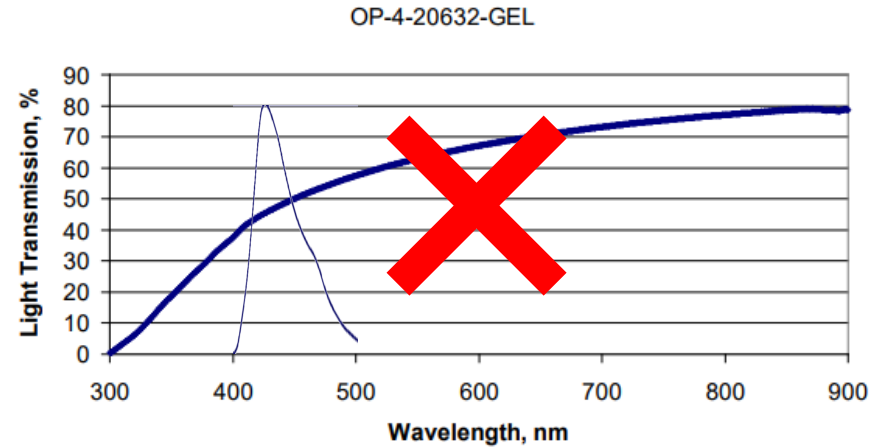
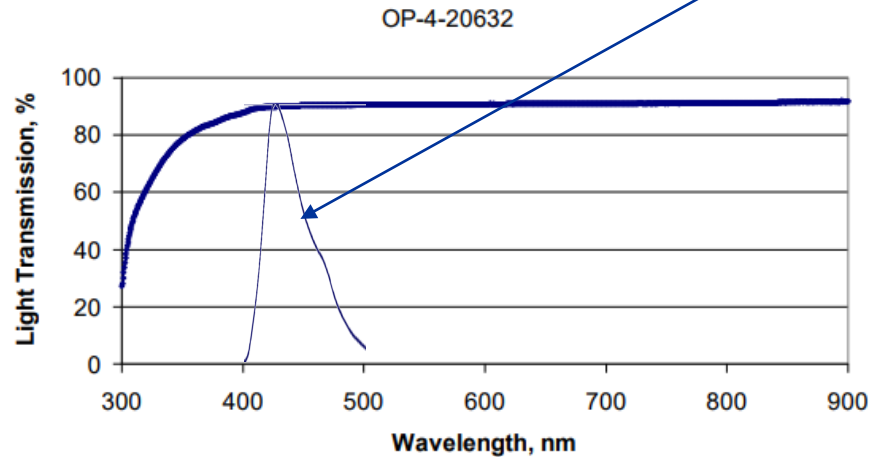
Transmission Curve

EJ-200 light emission spectrum



Transmission Curve

EJ-200 light emission spectrum



제조사마다 제공하는 transmission 측정 결과는 테스트 조건이 모두 다르므로 saturation 되는 지점의 파장만 보면 될 것
같음. Saint-Gobain社は transmission curve를 제공하지 않아, Eljen社の 동일제품 data sheet를 참조함.

Reference: Test 1

Work with 3 types of Optical grease

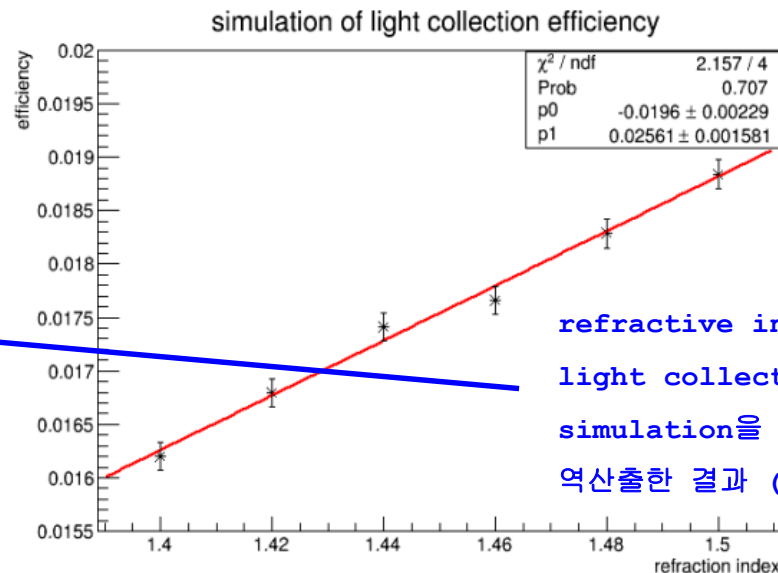
	Refraction index	Transparency (@315nm)	Light collection efficiency
OKEN	1.453	85%	1
TSF451-50M	1.404	98% (company)	0.8544
BC-630	1.465	95% (company)	0.9533

OKEN is the best.

The light collection efficiency was also obtained from the simulation (6*6*30 cm³ CsI +1 cm² APD)

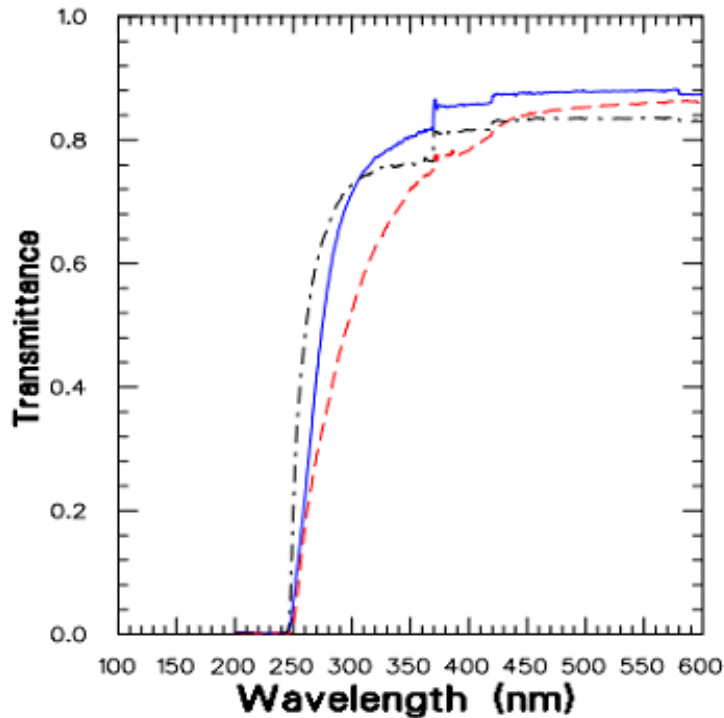
Refraction index	Light collection efficiency	Transparency (@315nm)
1.453	1.754%	1
1.404	1.62%	0.925
1.465	1.782%	0.938

We can calculate transparency from our measurement.



refractive index와 직접 측정한
light collection efficiency로부터
simulation을 통해 transparency를
역산출한 결과 (제조사 제공값과 상반)

Reference: Test 2



Dymax OP-19 UV glue (optical glue)

Dymax 9-20318-LV UV glue (plastic bonding glue)

Meltmount ogarnic glue

broader Landau distribution (no explanation found) but larger mean in Dymax OP-19 UV glue (optical glue)

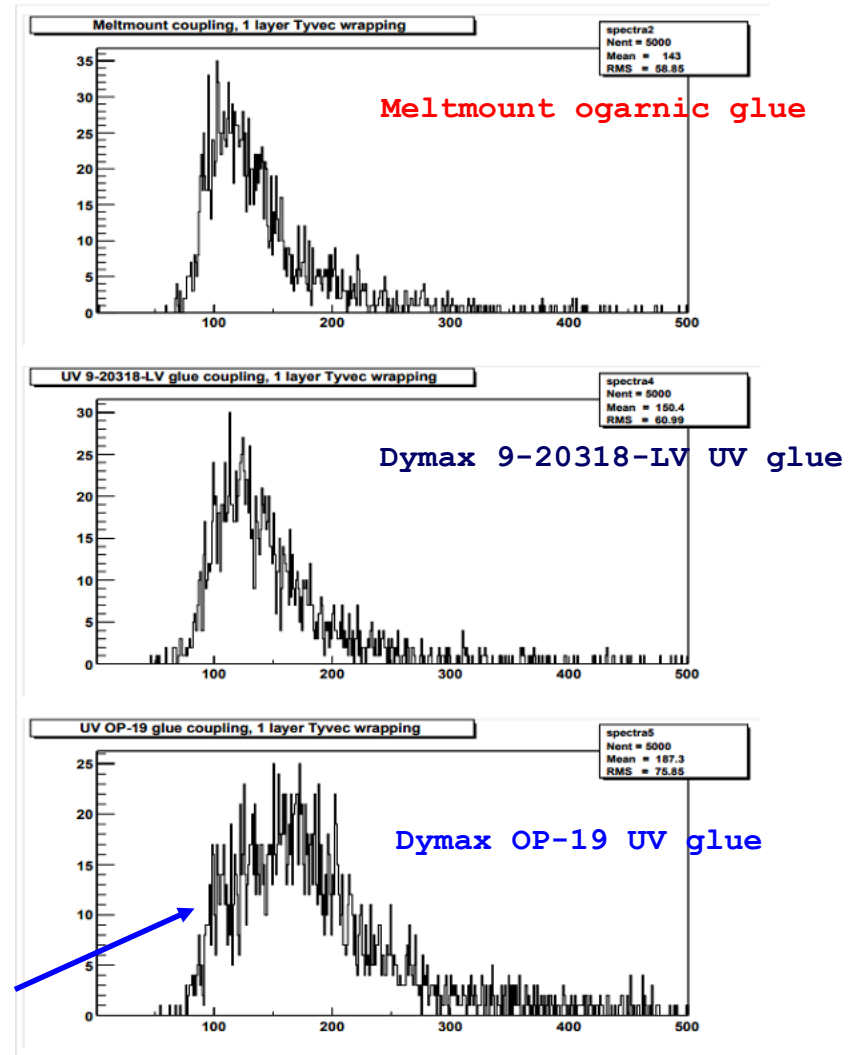


Figure 3: ADC spectra for different glue couplings of the PMT-block combination.

Reference

several tests, excellent gluing quality without any bubble and with good reproducibility has been obtained with the Stycast glue and $300 \times 300 \text{ cm}^2$ scintillator plates with a 2 mm thickness. However the gluing has proven to be more difficult with thicker 3 mm scintillator plates which are less flexible, resulting in little bubbles. Araldite was slightly more difficult to use. Bicron is an expensive glue without obvious advantage. The quality and reproducibility of the optical contact using the UV Dymax glue was excellent due to the simplicity of using this glue with a UV lamp. However an ageing of the scintillator yield has been observed when using this Dymax glue. It is probably due to the fact that we must flash the glue, and consequently the scintillator with a UV lamp in order to polymerize the UV glue. This flash might deteriorate the scintillator properties. In conclusion, the Stycast has been selected for BiPo-3.

Saint-Gobain BC-600 구입 관련



- Expiration Date
 - Optical Cement Resin 20171219
 - Optical Cement Hardener 20180208
- 유통기한 claim에 대한 Saint-Gobain 社の 답변

Hardener 유통기한 (20180208) 이전에 **mixin**해서 밀폐하여 서늘한 곳에 보관하면 6개월까지 사용 가능 (~ 201808)
- 교환하지 않는다면 다음주 월요일 (20171023) 저녁에 납품 받을 예정 / 교환 받는다면 4 ~ 6주 소요 예정