

Survey of high refractive index optical coupling materials

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Caveats:

- This list does not include adhesives.
- I don't claim that this is a totally comprehensive list. Further inquiries could be fruitful.
- In particular, I did not focus on cure-it-ourselves liquid silicone ingredients.

What I looked into:

- liquids and greases
- off the shelf silicone cookies
- make them yourself silicone cookies
- other materials

greases & liquids

- Eljen EJ-550, EJ-552: $n = 1.46, 1.47$

Standard grease; also the highest index grease I found.

Cleaning: lower alcohols (e.g. IPA) or soap and water.

- Cargille Refractive Index Liquids n up to 1.80

Cleaning: the $n=1.730$ and lower fluids are soluble in acetone (and other nastier solvents like toluene and xylene). Anything above $n=1.730$ has only partial solubility.

<https://www.2spi.com/category/refractive-index-fluids/cargille-immersion/>

- MKS (Newport.com) # F-IMF-105 liquid $n = 1.52$ @ 589 nm

Cleaning: acetone.

Viscosity = 100 cps (thick as molasses)

<https://www.newport.com/p/F-IMF-105>

transmission curve:

https://www.newport.com/mam/celum/celum_assets/resources/IML_150_transmission_Data.pdf?3

(I bought a syringe of this; now I just have to find it!)

off the shelf silicone cookies

- Eljen EJ-560 $n=1.43$ (Our standard cookie in the past.)
- Wacker Elastosil RT 604 (Nural has used.) $n = ?$

Index unknown at this point, but datasheet says: “The refractive index n_{D25} is between 1.404 and 1.410 for standard RTV silicone rubber. High refractive index grades achieve values of up to 1.5 and higher.” (But does RT 604 count as “standard”? What are the high refractive index grades?)

- Wacker Elastosil Film 2030 and Elastosil Film 624 $n = ?$

20 μ to 400 μ thick ← thin is good!

Haven't found index yet. (Need to contact manufacturer.)

make them ourselves silicone cookies

- Betely BQ-8352 (silicone) $n = 1.54$

cures at 130° C

haven't found details yet (Chinese company)

Cleaning . . . ?

- Betely BQ-4238, BQ-4238 (S), BQ-4242, BQ-4216, all $n = 1.54$

cure at 150° C (again, no details)

Cleaning . . . ?

<https://www.betelychina.com/products/led-filament-encapsulating-silicone/>

Other materials

- graded-index material: none found.
- List of other polymer indices besides silicone: **n up to 1.71**

<https://scipoly.com/technical-library/refractive-index-of-polymers-by-index/>

- Electron Microscopy Sciences Meltmount (reversible thermal adhesive) **n = 1.704**

<https://www.emsdiasum.com/meltmount-1704>

applied at 65° C

clean using toluene

“It’s soluble in Toluene . . . not sure if this will remove it or not. <https://www.emsdiasum.com/wax-stripper> “

High index, (supposedly) reversible → good

heated cure (and possibly heated removal) and toluene as a solvent → bad

Dead ends

(Even though these are not options for us, I include them to give an idea of what might be possible.)

- Shin-Etsu Chemical LPS-3600 Series $n = 1.55$ (589 nm)

This is the alternative cookie material that was sent to the test beam.

Room temperature cure.

Clean with IPA or ethanol. Avoid toluene & hydrocarbon solvents.

LPS-3600 Series is discontinued (but can't ship to the US anyway (hazardous chemicals)).

https://www.led-professional.com/products/leds_led_modules/shin-etsu-chemicals-high-refractive-index-silicone-to-improve-performance-of-high-brightness-leds

- Wacker LUMISIL[®] 590 and LUMISIL[®] 591 $n = 1.53$

These have been discontinued.

https://www.ledinside.com/products/2016/1/wacker_releases_new_high_refractive_index_silicones_for_leds

- Gelest Optisil 164A1 $n = 1.64$ discontinued

Hard silicone resin.

<https://www.gelest.com/wp-content/uploads/PP1-OS164A1-Optisil%C2%AE-1.64A1-TDS.pdf>

Supplemental information

SiPM: (Hamamatsu S14160-6050)

From Hamamatsu (regarding S14160-6050) $n=1.57$ (@peak PDE)

Dispersion curve:

400 nm : 1.58

450 nm : 1.57

500 nm : 1.56

600 nm : 1.55

700 nm : 1.55

[S1416x series' datasheet](#)

Recommend using ethanol for cleaning purposes of MPPC windows. (“There are concerns of acetone dissolving the MPPC’s protective resin. If possible, recommend using ethanol as an alternative.”)

“Avoid using toluene for cleaning purposes, as it can cause swelling of the protective silicone resin on the MPPC, which can lead to damage/failures. “

Supplemental information continued:

SiPM - more from Hamamatsu:

“Regarding optically coupling scintillators to our MPPCs, I have only seen records of recommendations to use “Optically Clear Adhesives” when coupling scintillators to windows. However, I can unofficially mention to take a look at Dow Corning’s DC-4 Insulating Compound or SYLGARD 184. The DC-4 is an insulating compound, and the SYLGARD 184 is a curing silicone. However, I am unsure of the index of refraction of these two compounds.”

filters

Filters from Hoya: $n=1.54-1.56$.

Summary:

material	type	cleaning	R.I.	comments
Eljen EJ-550, EJ-552	grease	IPA, soap & water	1.46, 1.47	standard grease
Cargille Liquids	liquid	Acetone or nothing	≤ 1.80	
MKS/Newport F-IMF-105 liquid	liquid	acetone	1.52 (589 nm)	UMD has some; "thick as molassas"
Eljen EJ-560	Silicone cookie	?	1.43	Standard cookie
Wacker Elastosil RT 604	Silicone cookie	?	1.41?	Nural has used.
Wacker Elastosil Film 2030 and Elastosil Film 624	Silicone film	?	?	20 μ to 400 μ thick
Betely BQ-8352	Make your own silicone cookie	?	1.54	Cures @ 130° C.
Betely BQ-4238, BQ-4238 (S), BQ-4242, BQ-4216	Make your own silicone cookie	?	1.54	Cures @ 150° C
other polymers	Non-silicone cookies	?	≤ 1.71	
Meltmount	reversible thermal adhesive	toluene	1.704	65° C application