

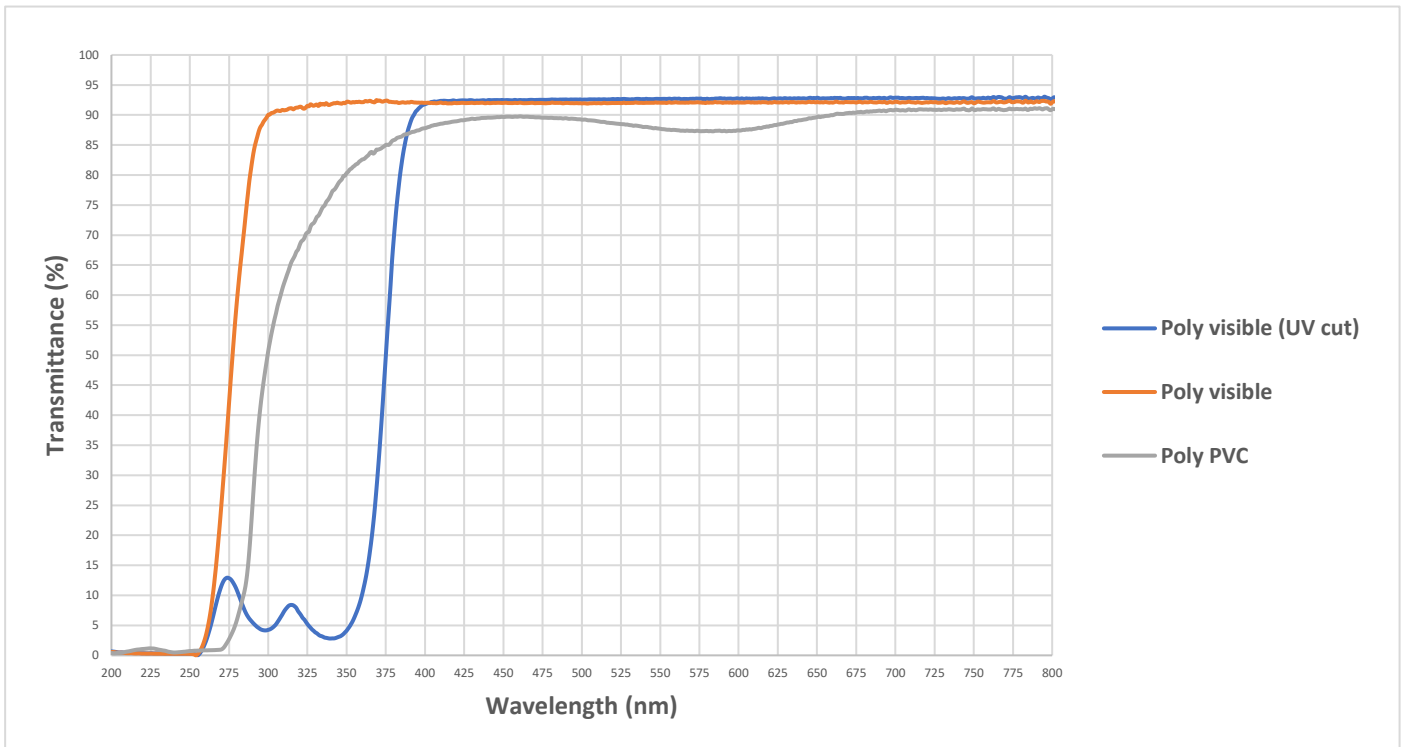
Optical Poly Materials of Fresnel Factory Inc.

This document describes the optical characteristics of Polymers of Fresnel Factory, such as the transmittance by wavelength band, tensile strength and etc. To choose a right material and **production methods** are essential to achieve proper optical property. If you need assistance please feel free to contact, ashton@fresnelfactory.com. Fresnel Factory Inc. also support design for optics and **tooling** as your requirements.

The table below summarizes the characteristics of the materials mentioned in this document. The table does not include PMMA used for casting, **PET flim+UV** resin used for roll-to-roll, and PMMA film used for hot-embossing. Also Fresnel Factory has all the general optical materials in addition to the materials mentioned above.

Material Name	Main Wavelength	Main Wavelength Transmittance	Tensile Strength	*Impact Strength	*Hardness (Rockwell Scale)	*HDT (0.46Mpa)	Properties
Poly visible (UV cut)	Visible	92.65%	66Mpa	16J/m	90(M Scale)	82°C	UV cut
Poly visible		92.06%	-	-	-	-	UV transmission
Poly PVC		89.16%	-	-	-	-	Thin, Flexible
Poly NIR212	Near Infrared	91.46%	62Mpa	694J/m	70(M Scale)	137°C	High strength High HDT
Poly FIR 200	Far Infrared (8~13um)	42.81%	24.5Mpa	30.15J/m	-	73°C	High Transmittance
Poly FIR 25		19.24%	26Mpa	70J/m	75 (R Scale)	93°C	High HDT

1. Material for visible(400~750nm) light



Fresnel Factory has 3 different material for visible light. Two PMMA based material, which is Poly visible(UV cut) and Poly visible, and one PVC based, which is Poly PVC. Poly visible(UV cut) is also used for Near Infrared depend on purpose.

Reference

*HDT(Heat Deflection Temperature) : It exhibits heat resistance at a specific temperature when the sample has displacement of 2.5mm under a specific load.

*Hardness : Abrasion resistance

*Izod Impact strength : Impact resistance

1-1) Poly visible(UV cut) and Poly visible



(F=2mm to F=2,000mm circle Fresnel lense)

Transmittance (%)

Material name	UVB(280~315nm)	UVA(315~400nm)	Visible(400~750nm)
Poly visible(UV cut)	6.3%	31.04%	92.65%
Poly visible	84.05%	92.65%	92.06%

FresnelFactory has Poly visible (UV cut) and Poly visible. Poly visible series is mainly produced by using hot-press(precise heat compression mold) using a pre-formed sheet with a thickness from 1mm to 5mm. This materials are using for Circle Fresnel, cylindrical Fresnel, LED lights, CPV and Large, some of MLA and Lenticular, and wide angle mirror.

Properties

Max Tensile strength	Impact strength	Hardness	HDT(0.45Map)	Melt Flow rate(230/3.8kg)
66Mpa	16J/m	Rockwell M sale 90	82°C	14g/10min

PMMA has the best visible light transmittance and weather resistance among resins. It has excellent hardness, abrasion resistance and heat resistance. Specific gravity is more than half lighter than glass and strength is similar to inorganic glass. In fact, PMMA has excellent strength and weather resistance, so it is used for aquariums that need to withstand high water pressure and taillights for automobiles exposed to weathering.

Since the melt flow rate is not good at 14g/10min (based on 230/3.8kg), high-pressure injection is required and the sprue runner and gate must be enlarged.

Therefore, Fresnel Factory is producing PMMA lenses by hot pressing most likely. Fresnel Factory provides custom-sized PMMA lenses by precision laser cutting.

1-2) Poly PVC



(Credit card magnifier)

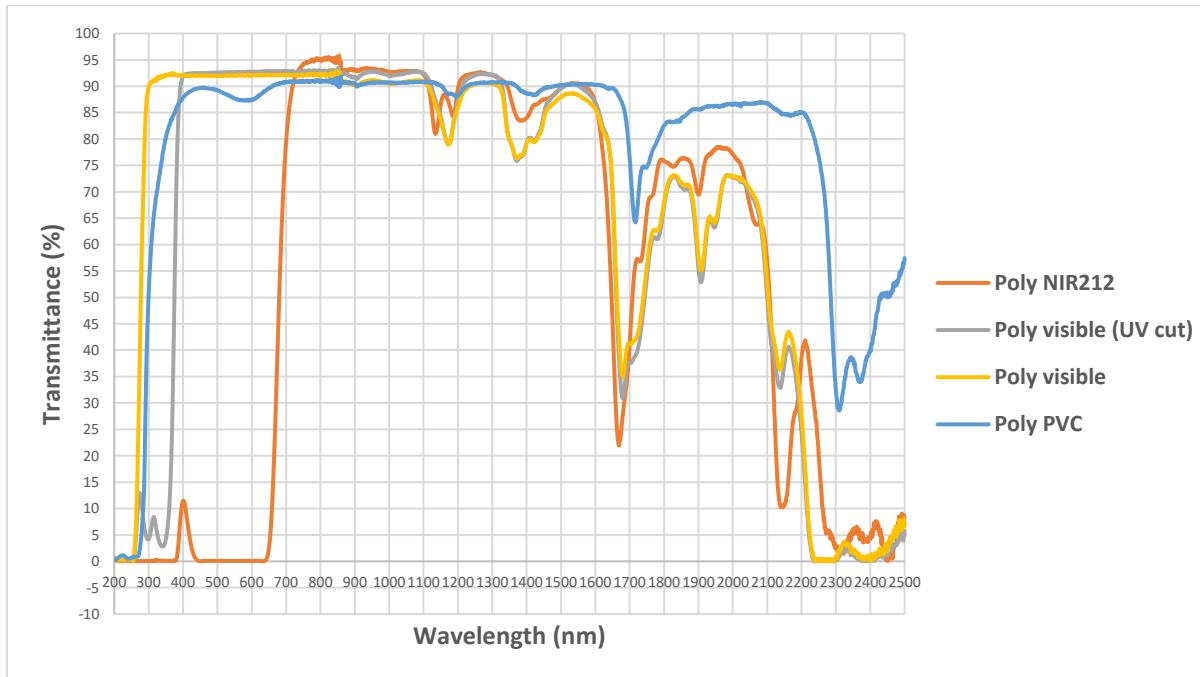
From the nature of PVC, it has excellent processability and can be produced with a thickness thinner than PMMA, normally Poly PVC is 0.4mm. Stiffness can be adjusted according to the amount of plasticizer. Poly PVC is low material cost and good productivity. It is mainly used for mass production of inexpensive consumable lenses, such as credit card magnifiers, which have low optical point quality. Sharpness of each prism is also low compared to PMMA.

Transmittance (%)

Material name	UVB(280~315nm)	UVA(315~400nm)	Visible(400~750nm)
Poly PVC	40.23%	80.06%	89.16%

The visible wavelength transmittance of Poly PVC is 89.16% at 0.4mm thickness.

2. Material for NIR(Near Infrared) wavelength



(Graph2 – Transmittance of NIR(near infrared) material)

2-1) Poly NIR212



(Fresnel Factory NIR lenses)

Transmittance

Material name	UV and Visible(280~750nm)	NIR(750~1,400nm)
Poly NIR212	6.96%	91.46%

Poly NIR212 shows very excellent transmittance in the NIR (750~1400nm) and blocks most of the UV and visible Wavelength. It blocks 93.07% of UV and visible wavelength and shows an average transmittance of 91.46% in the main wavelength of Near Infrared.

Poly NIR212 not only has high transmittance of NIR, but also acts as a band pass filter of visible wavelength to prevent malfunction of the photo diode. Poly NIR212 is produced and supplied by custom-made, and mainly produced by injection method.

Properties

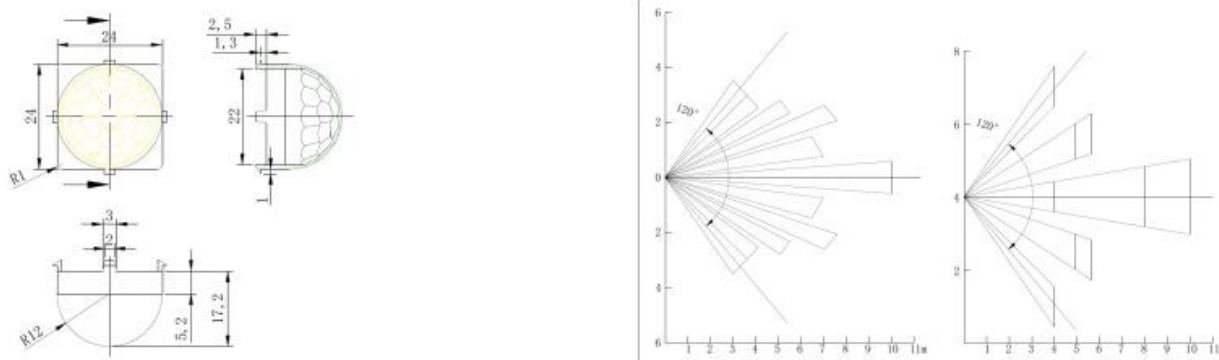
Max tensile strength	*Impact strength	*Hardness	*HDT(0.45Map)	Melt Flow rate(230/3.8kg)
62Mpa	694J/m	Rockwell M sale 70	137°C	20g/10min

Poly NIR212 has excellent tensile strength, impact strength, hardness and HDT. Fresnel Factory uses Poly NIR212 for NIR sensing devices exposed to high temperatures and vibrations in the vehicle during summer.

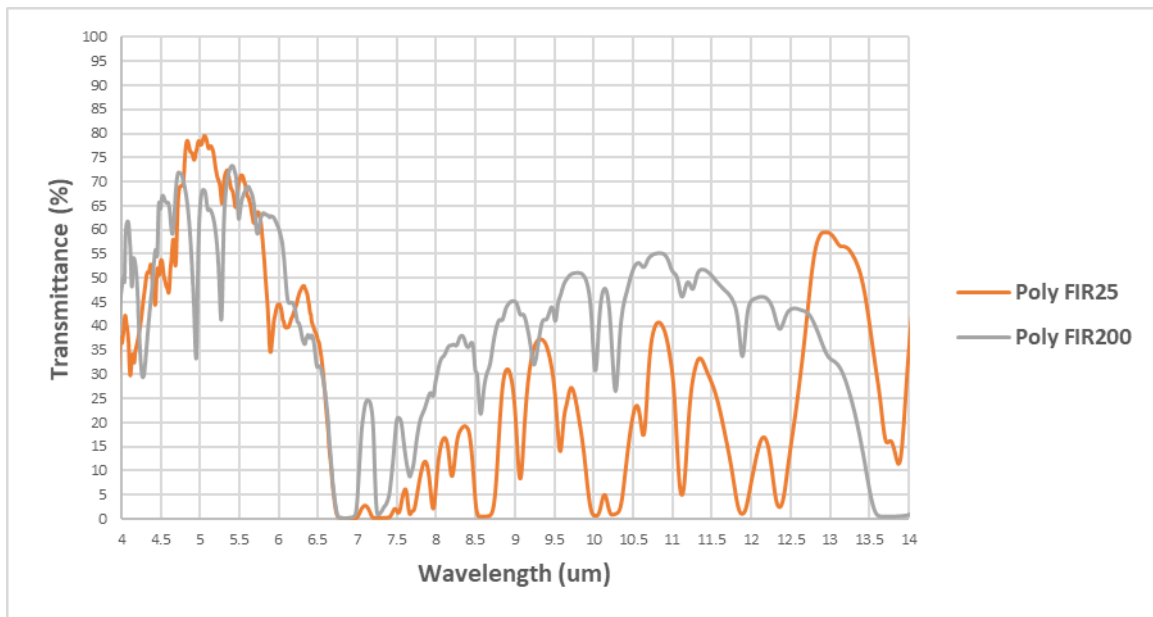
3. Material for PIR/FIR(8~13um) wavelength

The thermopile and passive infrared sensor that is using for motion sensor detects the wavelength of 8~13um.

Without Fresnel lens, the sensor only can detect less than 1m distance and narrower space with lens. To work with Pyroelectric detector and thermopile, Fresnel lens that collects infrared rays as a sensor is required. Fresnel Factory manufactures Fresnel lenses for passive infrared and absolute temperature sensors.



<Dimension and FOV(Dome Type Fresnel Lens FOV)>



(Graph3 – Transmittance of PIR, FIR(Far infrared) material)

Material is important to have a wide FOV and excellent Far Infrared transmittance. Therefore, Fresnel Factory is using Poly FIR200 and Poly FIR25, which have a wide FOV and excellent FIR transmittance.

3-1) Poly FIR 200



(Fresnel Factory's PIR lens)

Transmittance (%)

Material name	8~12um
Poly FIR200	42.81% at 0.65T

PIR(Passive Infrared) sensor detects infrared rays in the 8~12um wavelength emitted from body temperature. Fresnel Factory's Poly FIR200 has an excellent transmittance of 42.81% on average from 8~12um wavelength when 0.65T.

Properties

Max tensile strength	Impact strength	HDT(0.45Map)	Melt Flow Rate
24.5Mpa	30.15J/m	73°C	20g/min

The price is low since the productivity is high because the melt flow rate is excellent and the time required for injection is short. Despite having the above properties, it is not suitable for use in environments exposed to high temperatures, impacts, and scratches due to its low hardness, impact strength, and HDT compared to Poly FIR25.

3-2) Poly FIR 25



(Fresnel Factory's temperature sensor)

Transmittance (%)

Material name	8~13um
Poly FIR25	19.24% at 0.50T

The FIR (Far-Infrared) sensor detects temperature by measuring infrared emitted from an object and is used in thermal imaging cameras. The transmittance of Poly FIR25 in the 8~13um wavelength is 19.24% on average, which is lower than that of Poly FIR200. However, Poly FIR25 has better Hardness and high resistance of temperature.

Properties

Max tensile strength	*Impact strength	*Hardness	*HDT(0.45Map)	Meltflow Rate
26Mpa	70J/m	Rockwell M scale 70	130°C	2.5g/min

Poly FIR25 has higher tensile strength, impact strength, and HDT than Poly FIR200.

Due to the above properties, Poly FIR25 is used for temperature sensing sensors exposed to high temperatures despite low transmittance.

Reference

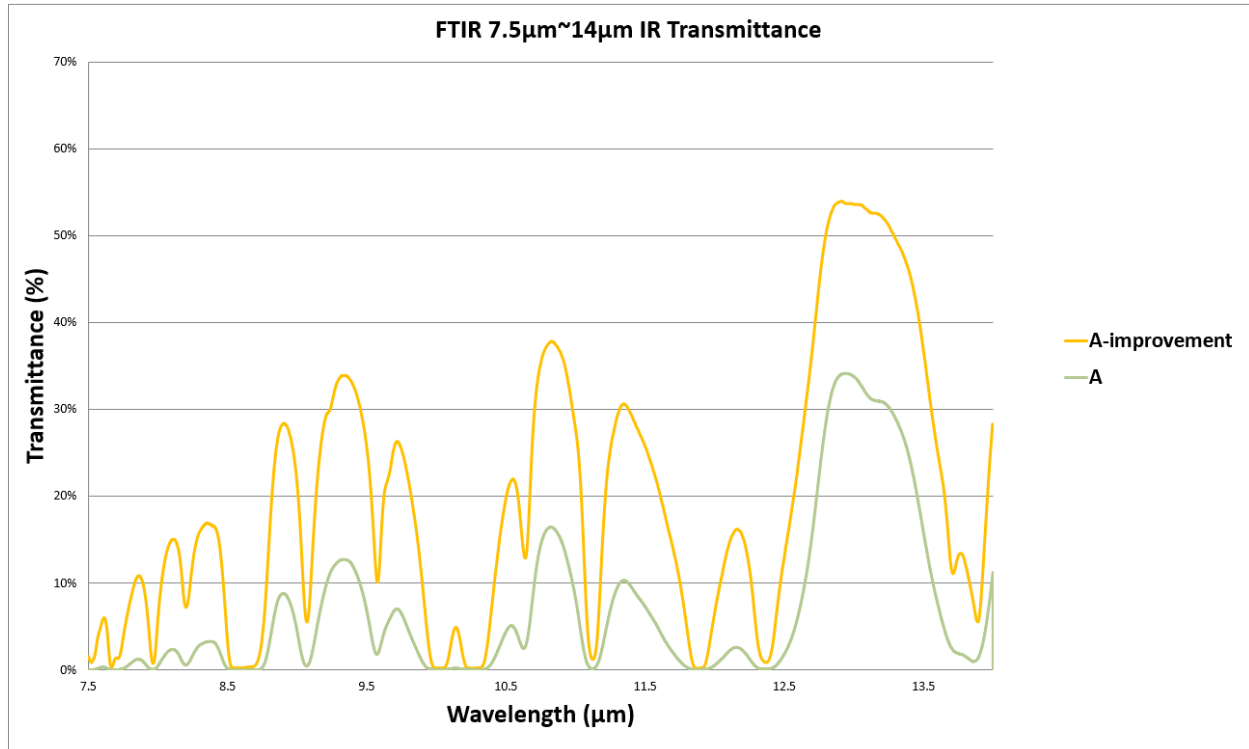
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*Hardness : Abrasion resistance

*Izod Impact strength : Impact resistance

4. Transmittance enhance process of Fresnel Factory Inc.

Fresnel Factory Inc. has excellence skill in mold design, tooling and production for optics. With this skills, we are manufacturing lenses to higher quality. Therefore, even with the same poly material, Fresnel Factory produces better transmittance. The graph below is an example of an achievement for improving transmittance.



<(Poly FIR25) Comparison graph before and after the transmittance improvement process>

Poly FIR25 was originally a material having a low transmittance of about 10%, but the transmittance increased by more than 10% through a process of improving the transmittance of Fresnel Factory. Fresnel Factory is a professional optical company that undergoes an injection process that align with optical properties of each material.

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