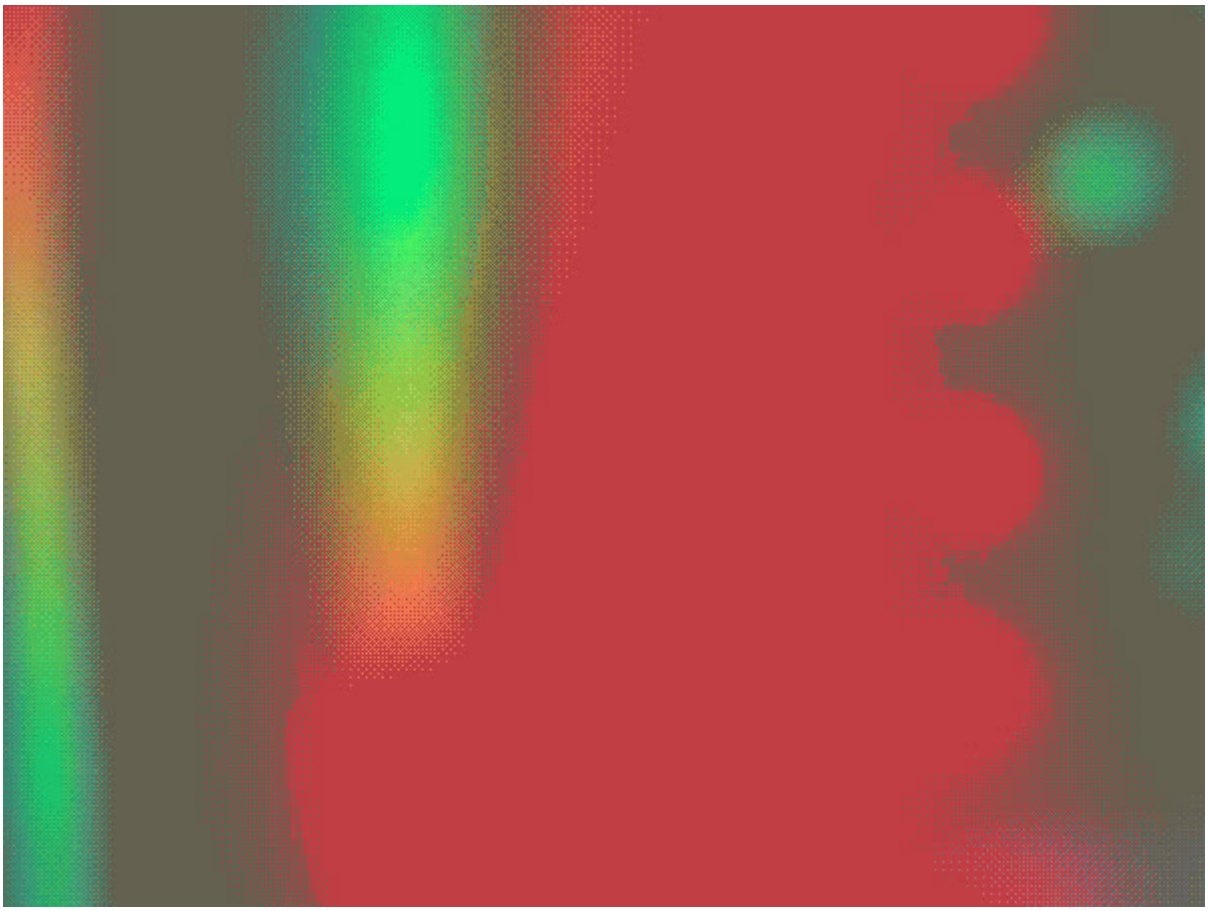
Make it Glow: NeoPixel and LED Diffusion Tips & Tricks

Created by Erin St Blaine



https://learn.adafruit.com/make-it-glow-neopixel-and-led-diffusion-tips-tricks

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Table of Contents

Overview 5

- What Is Diffusion?
- Diffusion and NeoPixels
- LED Test Setup

Plastics 7

- Black LED Acrylic
- HDPE (High Density Polyethylene)
- Prismatic P12
- P95 Lighting Sheets
- Innsbruck
- Satinice White
- Smooth Matte Acrylic
- Quarter Inch Acrylic

Foam 15

- LED Foam - 4mm
- LED Foam - 8mm
- Packing Foam

Paper 18

- Copy Paper
- Paper Towels
- Parchment Baking Paper
- Wax Paper

Fabrics 22

- Fun Fur
- White Sequin Fabric
- Lace
- Lining Fabric
- Mesh / Tulle
- Neoprene Scuba Fabric
- Rib Knit Cotton
- White Satin
- Faux Sheepskin
- Fosshape / Felt
- Velvet

Infinity Mirrors 30

- Acrylic One-way Mirror
- Infinity Mirror Coaster
- Infinity Mirror Collar
- Bubble Table with LED animations and IR Control

Pre-Diffused Strips 31

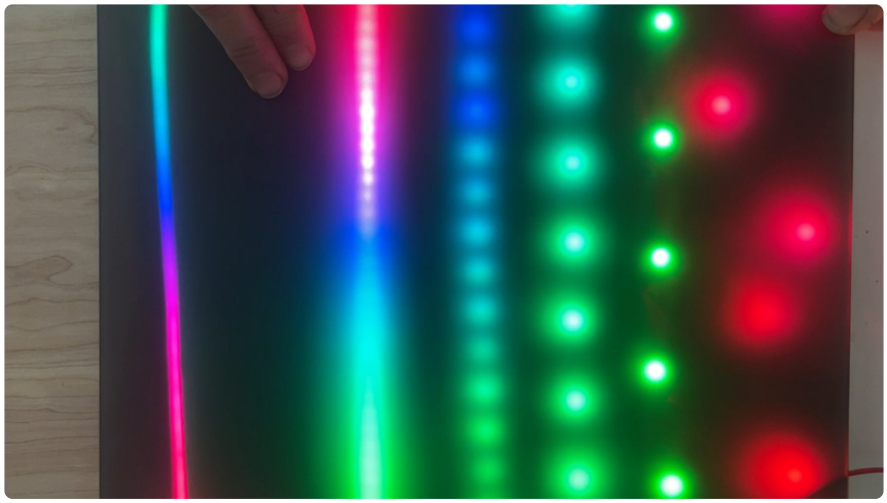
- Ideas for Use
- LED Neon Signs with NeoPixels
- Stick Person Costume with LED Strips
- LED Neon Selfie Spot
- NeoPixel Mickey Ears

Other Ideas 34
• Webbing
• Hot Glue
• Polyester Fiberfill
• Bubble Wrap
• Cricut Vinyl

Overview

NeoPixels and other addressable LED strips are so much fun to use, and there are so many possibilities and ways to make beautiful things. The pixels are gorgeous on their own, but when they're diffused through or reflected off other objects, they can become pure magic.

Adafruit's engineers and artists have pooled some of our experience and knowledge about diffusion materials and techniques. We've tested some common materials, as well as specialty materials and interesting stuff we've found and love in hopes that you'll be inspired and accelerated on your journey toward making beautiful things with electronics.



What Is Diffusion?

Diffusion is the scattering of light by transmission or reflection. When light passes through a diffusing material, such as a frosted glass or a piece of plastic, the material scatters the light in many different directions, which reduces the intensity and sharpness of the light. This happens because the diffusing material contains microscopic irregularities, such as tiny air pockets or particles, that cause the light to refract and reflect in different directions. As a result, the light becomes more evenly distributed and softer, creating a more diffuse and pleasing effect. The amount of diffusion depends on the degree of irregularities in the diffusing material, as well as its thickness and distance from the light source.

Diffusion and NeoPixels

NeoPixel LEDs are a popular choice for creating dynamic and colorful lighting displays, but sometimes their brightness and sharpness can be too intense for certain projects. This is where diffusion comes in. Diffusing NeoPixel LEDs involves softening the light emitted from the individual LEDs to create a more even and diffuse glow. Diffusion can help to reduce the harshness of the light, make it easier on the eyes, and create a more aesthetically pleasing effect. This tutorial will explore various methods for diffusing NeoPixel LEDs and how to achieve the desired level of diffusion for your specific project.

LED Test Setup

I'm running a rainbow animation on 6 different types of LED strips. From left to right:

1 x RGB Neon
Flexible Silicone Neon-like Skinny NeoPixel LED Strip - 96 LEDs per meter
https://www.adafruit.com/product/4310

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1 x 144/m NeoPixels
Adafruit NeoPixel Digital RGB LED Strip 144 LED - 1m White - WHITE
https://www.adafruit.com/product/1507

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1 x 60/m NeoPixels
Adafruit NeoPixel Digital RGB LED Strip - White 60 LED - WHITE
https://www.adafruit.com/product/1138

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1 x 30/m NeoPixels
Adafruit NeoPixel Digital RGBW LED Strip - White PCB 30 LED/m
https://www.adafruit.com/product/2832

Adafruit NeoPixel LED Dots Strand - 20 LEDs at 2" Pitch

1 x 2" NeoPixel Dots — https://www.adafruit.com/product/3630

Adafruit NeoPixel LED Dots Strand - 20 LEDs at 2" Pitch

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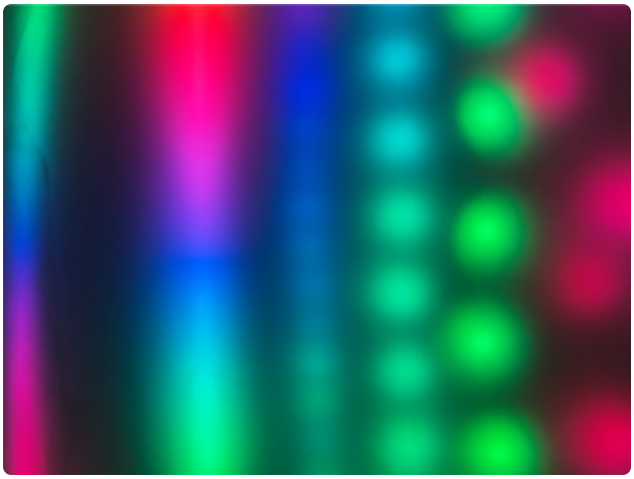
1 x NeoPixel Fairy Lights — https://www.adafruit.com/product/4917

Fixed Address NeoPixel LED Fairy Lights - 100 Wired LEDs

For diffusion, the material matters a lot, but the distance at which you place the diffusing material matters even more. I've taken some images and video of a lot of different materials, first with the material flush against the strips, and then hovering about 1" away. In the video clips I slowly pull the material further from the strips until it's about 8 inches from the table.

All photos and video were taken on an iPhone 12pro with no editing or color correction.

Plastics



Black LED Acrylic

This material is 2.6mm (0.1") thick and is made of special cast acrylic that makes it perfect for glowy projects, especially matrices or NeoPixels.

Unlike smoke or other-tinted acrylic, this material sharpens the pixels and reduces the glare. You get a great looking display, all colors are vivid and readable indoors and out!

Black LED Diffusion Acrylic Panel - 10.2" x 5.1" - 0.1" / 2.6mm thick

1 x Black LED Acrylic 10.2 x 5.1 https://www.adafruit.com/product/4749

Black LED Diffusion Acrylic Panel - 10.2" x 5.1" - 0.1" / 2.6mm thick

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1 x Black LED Acrylic 12x12 https://www.adafruit.com/product/4594

Black LED Diffusion Acrylic Panel 12" x 12" - 0.1" / 2.6mm thick

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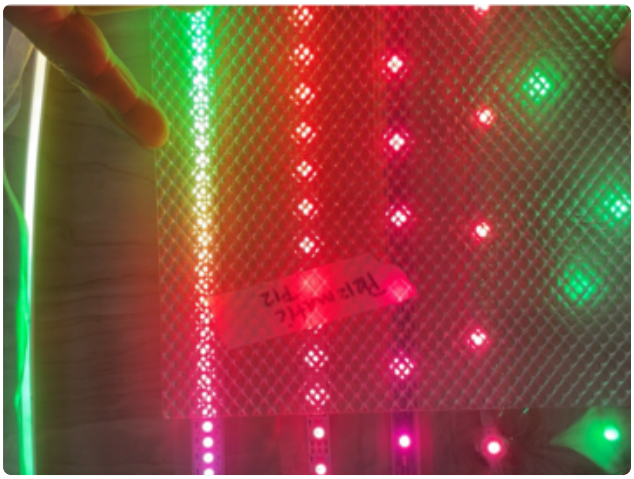
HDPE (High Density Polyethylene)

From the Tap Plastics website (https://adafru.it/18B8):

HDPE stands for high density polyethylene sheets. HDPE is a thermoplastic made from petroleum. HDPE cutting board sheets are NSF listed and FDA approved, making them perfect for commercial cutting board needs and safe for direct food applications. We produce custom sized high-density polyethylene plastic (HDPE) cutting boards in addition to the standard 24x24 plastic cutting board.

HDPE comes in a wide variety of forms: black commercial cutting boards are commonly found in restaurant back room prep areas and white plastic cutting boards and cutting sheets are commonly found in front of house prep areas or buffet lines.

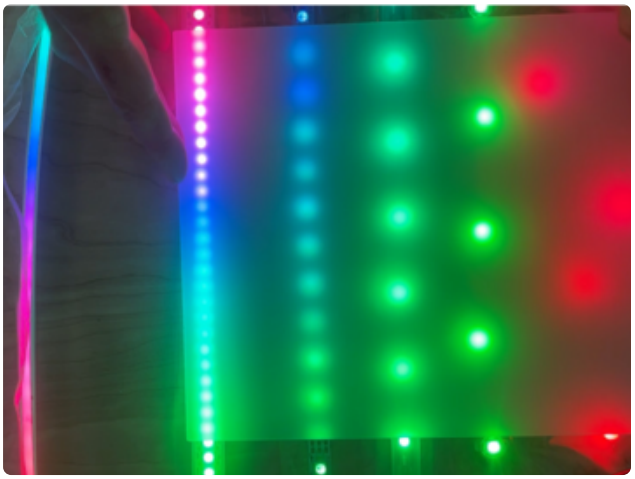
If you need just a small piece for a project, plastic milk jugs are typically made from HDPE (look for the “2” recycling mark).



Prismatic P12

Used to cover and diffuse fluorescent lights. This stuff is mostly clear and fairly flexible. It makes a very interesting prismatic diffusion pattern. It's about $6–7 per square foot for a large piece, but I found a small sample size at Tap Plastics for just a couple dollars.

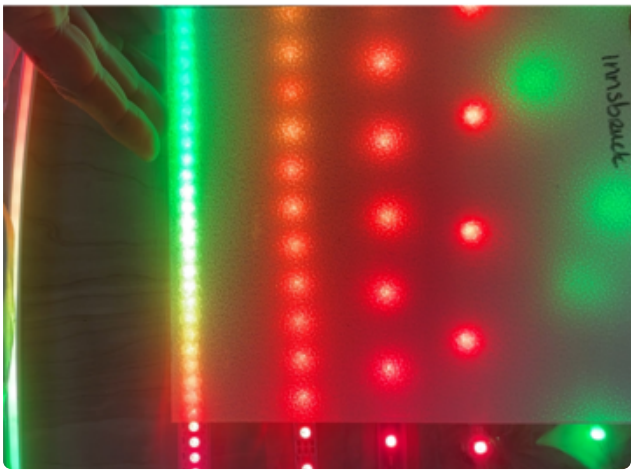
Prismatic P12 (https://adafru.it/18B9)

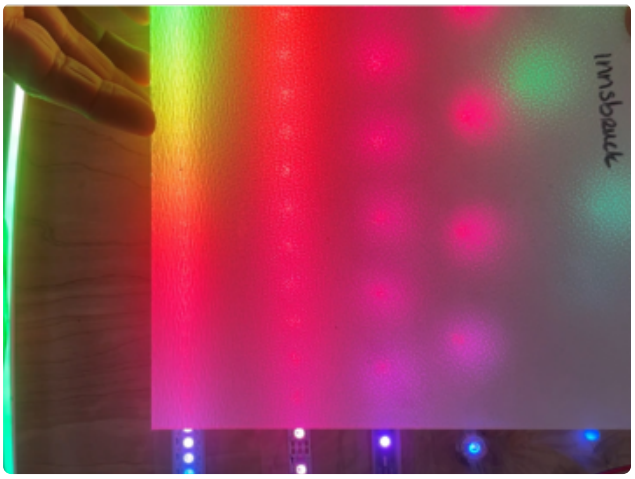


P95 Lighting Sheets

From the Acme Plastics Website: What is P95? (https://adafru.it/18Ba)

Coming in at around $10/square foot, this P95 lighting plastic does a great job of diffusing the lights. It looks especially good at a slight distance. This is the matte white version from Tap Plastics (https://adafru.it/18Bc).





Innsbruck

Textured acrylic Innsbruck in white, 1/8" thick. This is a nice lightweight textured plastic that gives a fuzzy look to the lights. It doesn't do a great job up close but looks lovely a few inches away.

Available at Tap Plastics (https://adafru.it/18Bd)

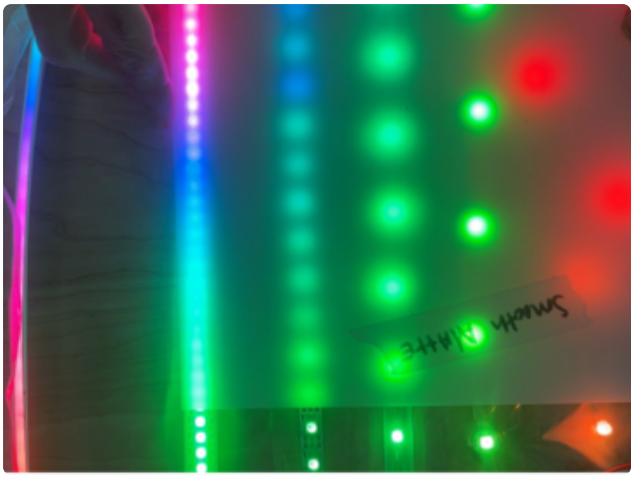
Satinice White

From the Tap Plastics website (https://adafru.it/18Bg):

The surface of ACRYLITE® Satinice is robust, pleasant to the touch, and good at discreetly diffusing light. Satinice white acrylic sheets are continuously manufactured with an appearance of glass and a frosted finish to enhance any design or backlit applications. As an added benefit for areas with high traffic, the textured surface resists fingerprints and is easy to clean. From store fixtures to outdoor displays, the possibilities are endless with Satinice white acrylic at the ready. Stimulate the imagination by stocking up today for whatever project awaits you.

Characteristics of Satinice White Acrylic Sheets:

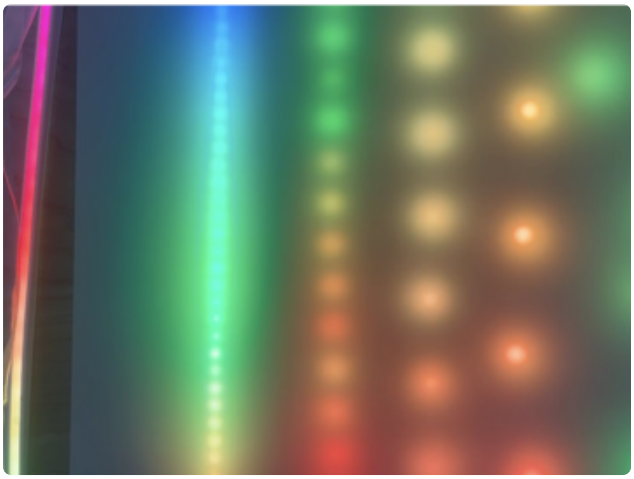
up to 59% transmission
translucent
UV absorbent
light matte surface (two-sided) with light diffusing beads embedded in the acrylic

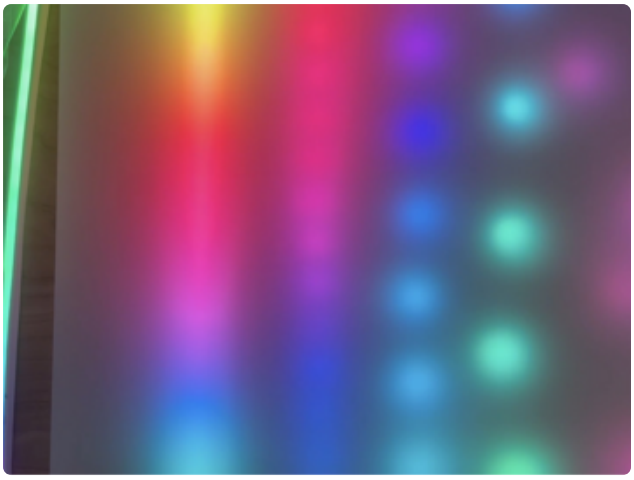


Smooth Matte Acrylic

Cast acrylic is one of the less expensive types of plastic available. This is a 1/8" thick piece of matte white acrylic from the Tap Plastics sample bin.

Tap Plastics (https://adafru.it/18Bc)

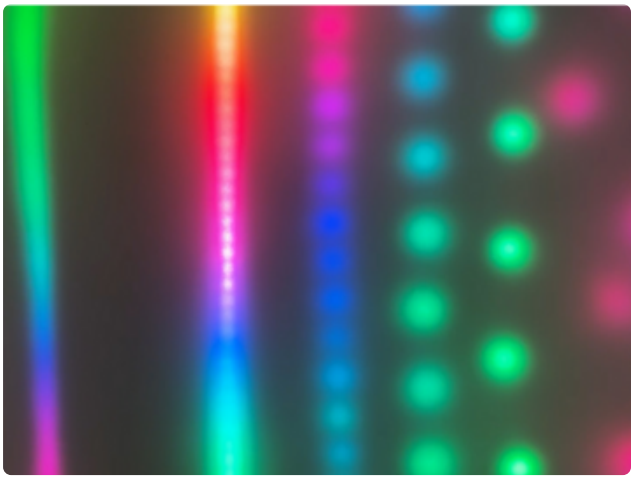


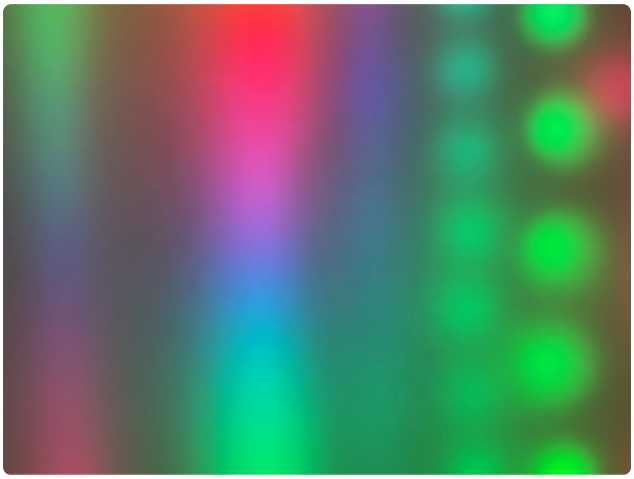


Quarter Inch Acrylic

All the above samples were 1/8" or less in thickness. This is a piece of 1/4" thick acrylic plexiglass from Amazon (https://adafru.it/18Bi). It's a little more expensive than the thinner stuff, at almost $15 for a square foot. It does a good job of diffusing the lights, but it's thick enough that it dims the light strips noticeably. It will also add a lot of weight to your project, but also a lot of strength.

Foam

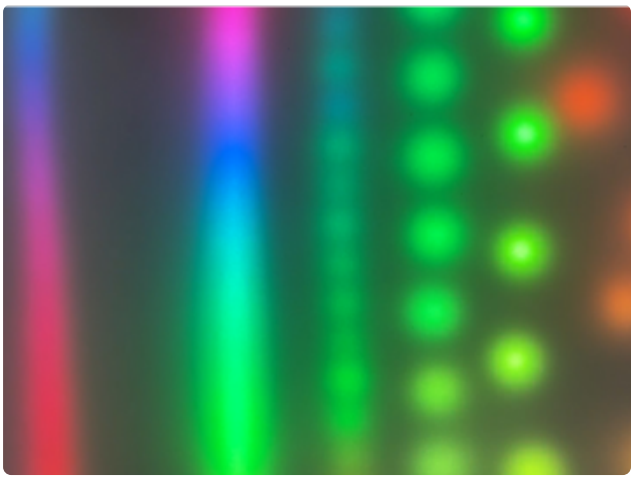


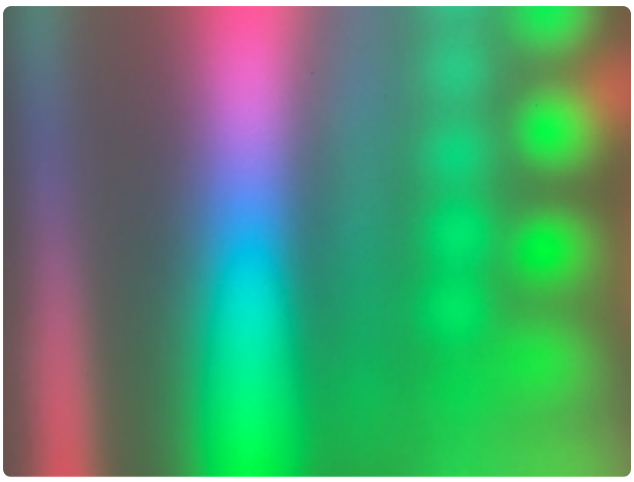


LED Foam - 4mm

This is specialty LED foam, made specifically for diffusing LEDs. It's on the pricier side. If you've got a really small amount of space and need very efficient diffusion, this stuff really does work great. But at $8 per square foot, a large project could get pretty expensive.

Plastazote LD45- Led Foam - Light Diffusing Sheets - for Cosplay - Costuming - Craft - Eva Foam- and Lighting Installations (Half Size (20" x 20"), 4 mm) White (https://adafru.it/18Bk)

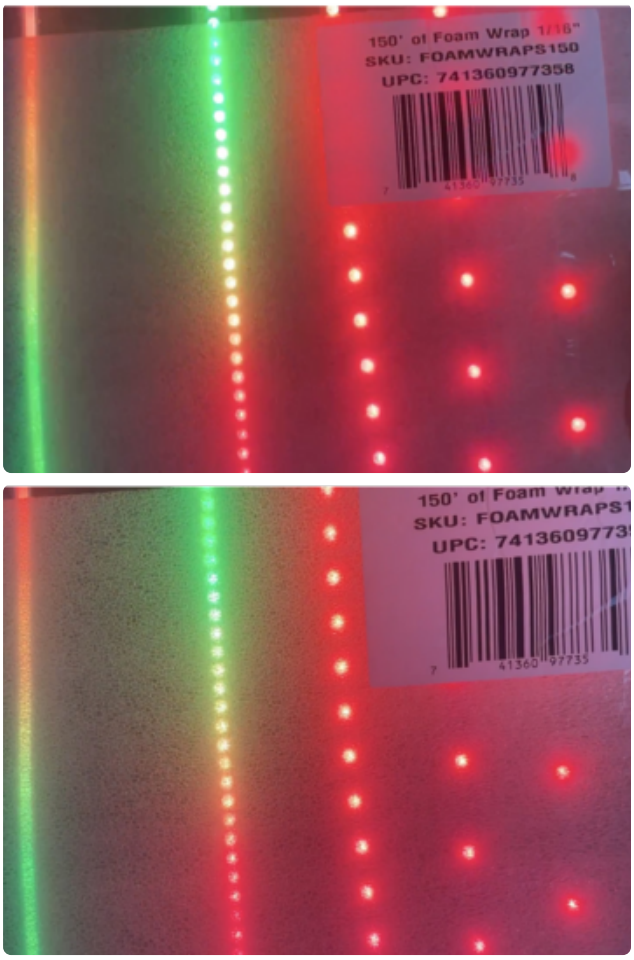




LED Foam - 8mm

The 8mm foam looks roughly the same as the 4mm at close range, but seems to do a fair bit more diffusion as I give it some distance.

Plastazote LD45- Led Foam - Light Diffusing Sheets - for Cosplay - Costuming - Craft - Eva Foam- and Lighting Installations White Half Size (20inch x 20inch) (https://adafru.it/18Bn)

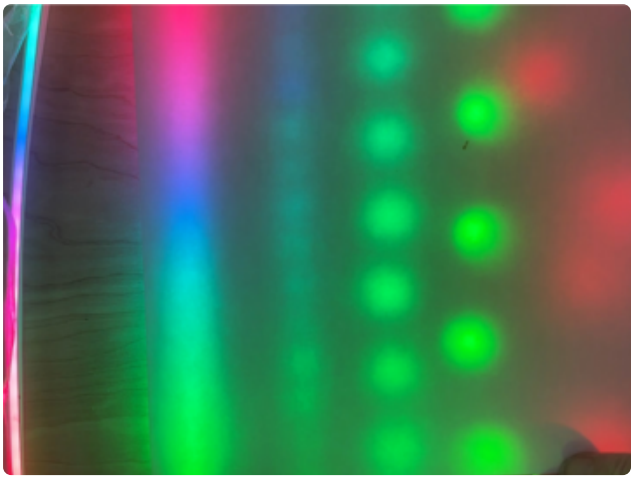


Packing Foam

This is a lightweight packing foam, sold as a mailing / moving supply. It's really thin and inexpensive - you can get a 150' roll of this stuff for $15. The price is right, but the diffusion is noticeably less good than the pricey specialty LED foam. It helps a bit to use multiple layers, but looking at this next to the expensive foam really points out how good the fancy stuff is.

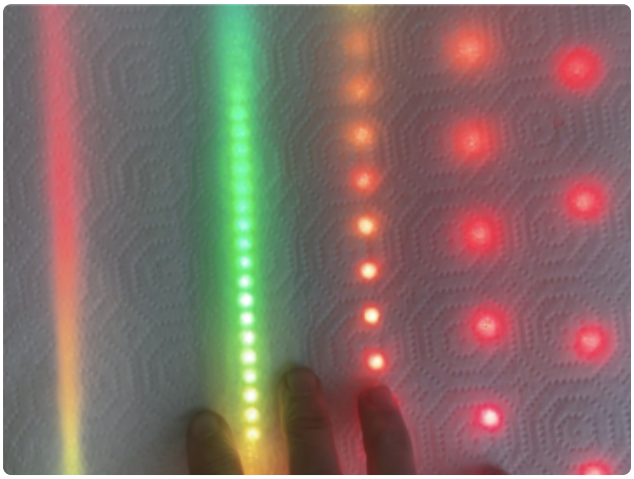
UBOXES foam wrap roll on Amazon (https://adafru.it/18Bq)

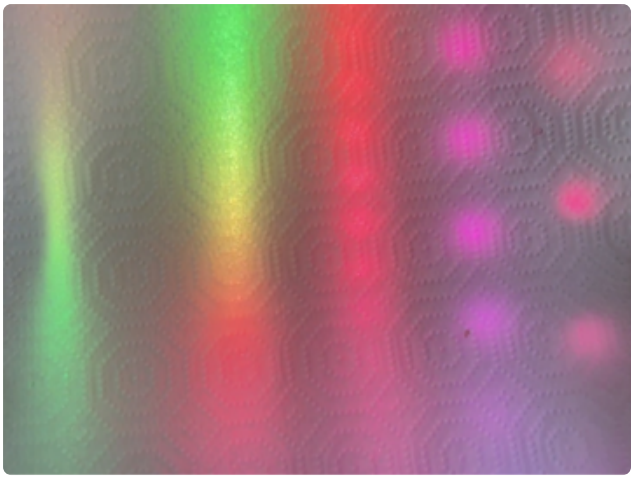
Paper



Copy Paper

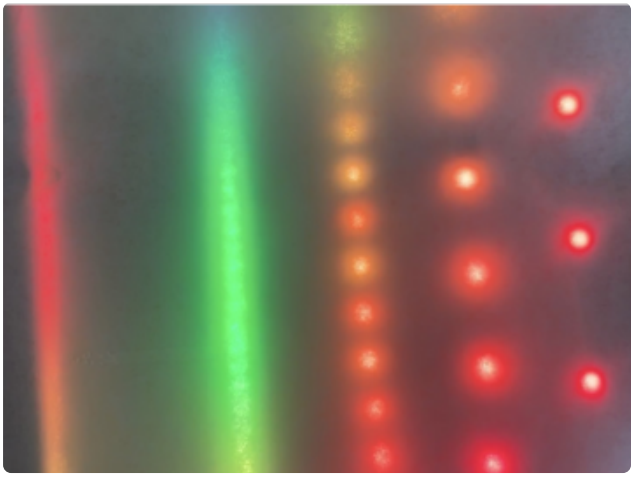
This is a sheet of regular printer / copy paper. This is probably the best bang for your buck - it does a really decent job of diffusing the lights for practically free.

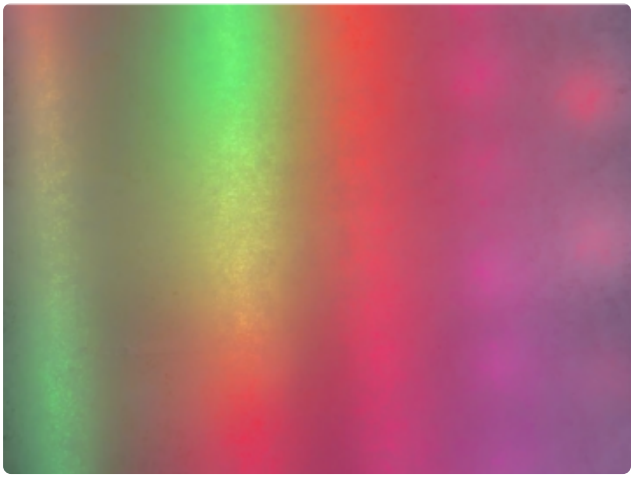




Paper Towels

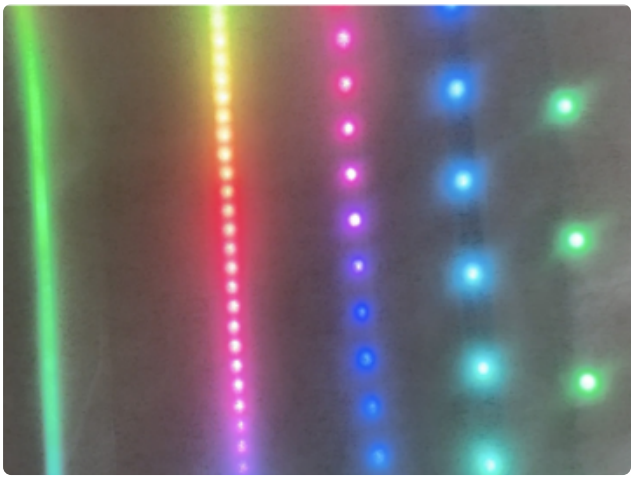
In a pinch, it's easy to grab a paper towel to diffuse your lights. The quilted texture makes a fuzzy look which is actually pretty interesting. They're inexpensive, easily available, and will also keep your spilled coffee away from your project.

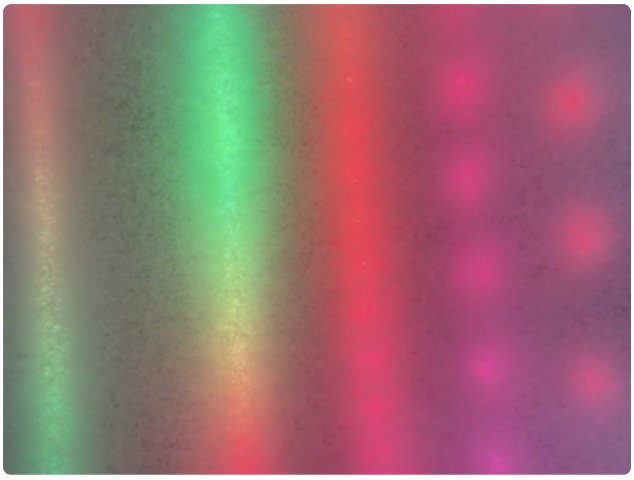




Parchment Baking Paper

Parchment baking paper comes in a long roll and is around 18" wide. It's a surprisingly good diffuser, giving a slight textured look to the LEDs. Hold it a few inches away and you get a Japanese rice paper-type look.

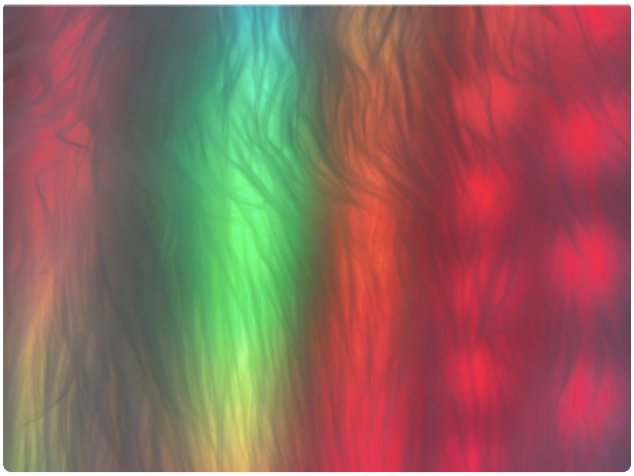


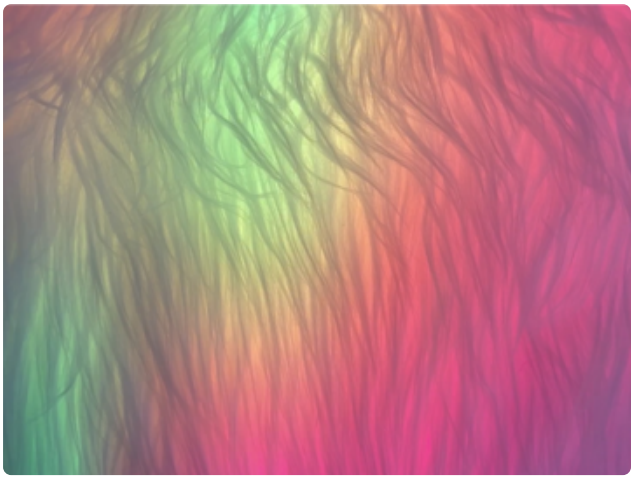


Wax Paper

Wax paper looks fairly similar to parchment paper but with more of a glossy, shiny surface. This might be harder to use as a diffuser since it's made to be non-stick and may repel some glues. In general, I prefer the look and feel of the parchment paper.

Fabrics

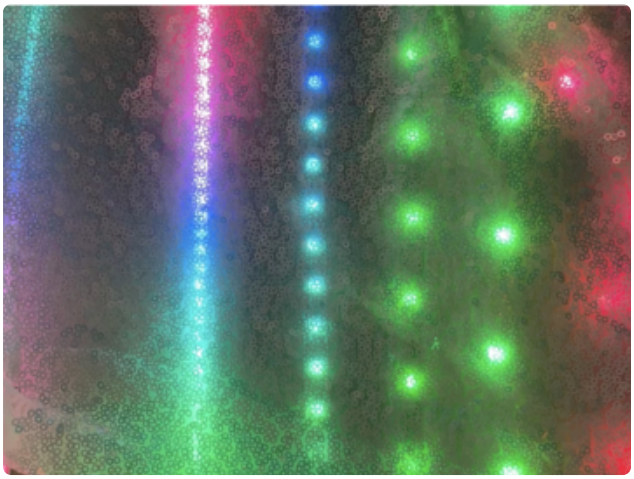


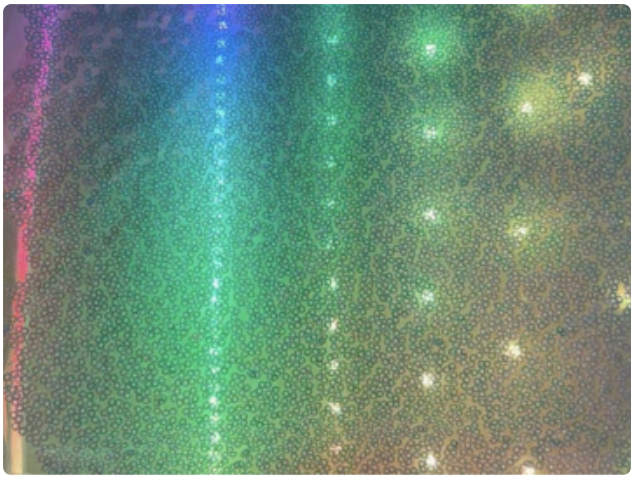


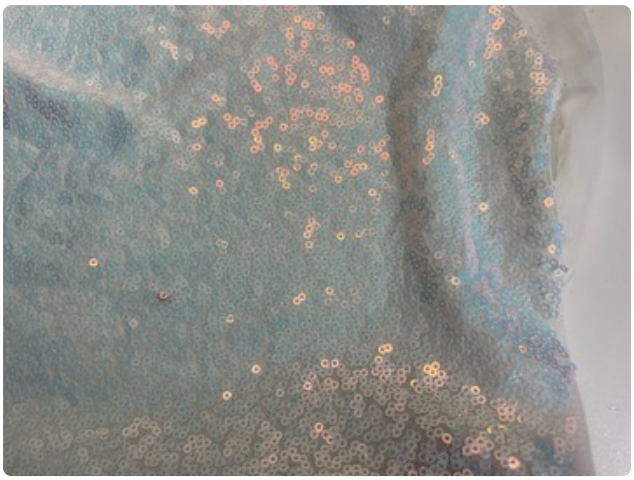
Fun Fur

This is a long pile white polyester fun fur. This is probably my favorite of all the diffusion materials. It looks and feels fabulous and diffuses any kind of LED strip beautifully. A little distance gives a gorgeous psychedelic matrix type effect. Fun fur FTW. Usually around $20-$30/yard depending on your source and how nice it is.

Find it on Fabric Empire (https://adafru.it/18Bt)







White Sequin Fabric

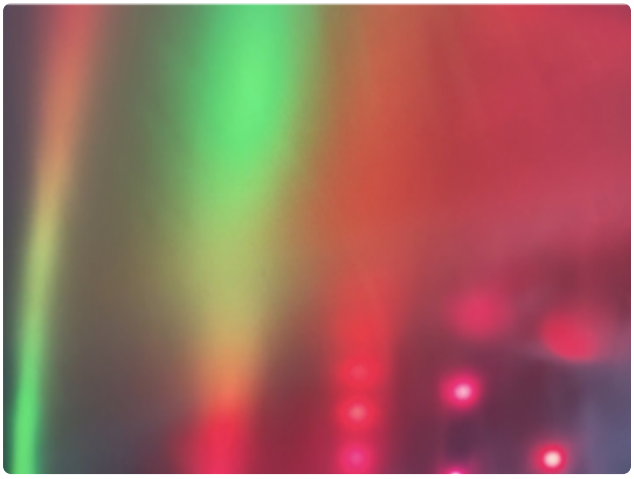
This is a piece of medium-weight polyester fabric with iridescent sequins on the front. It diffuses the lights fairly well but the sequins and shininess really get lost. I had pretty high hopes for this one but ended up a little disappointed.

Shiny things are shiny because they are reflecting light back at the viewer. In order to see the shine and sparkle, the light needs to be bouncing off the front of the sparkly thing, which means it needs to be coming from behind you. Using something like this for diffusion means the light is coming from behind the fabric instead, eliminating all the sparkle.

Lace

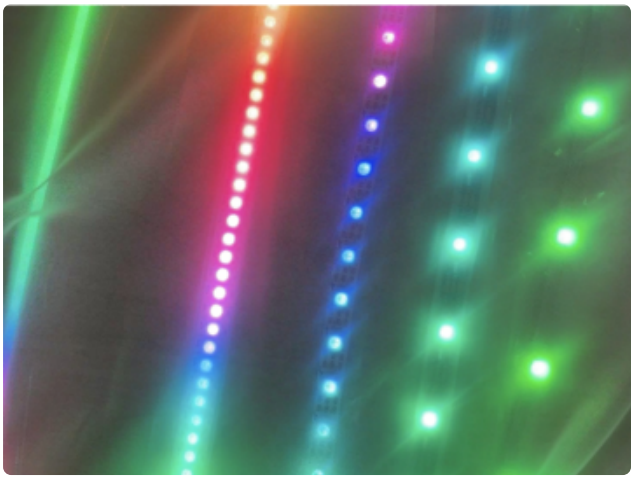
Lace comes in so many formats. You can find zillions of different patterns online. It comes in narrow trims and full fabric widths.

Most lace is pretty transparent, so doesn't do a super great job of diffusing the LEDs, but it sure does make a pretty effect anyway.



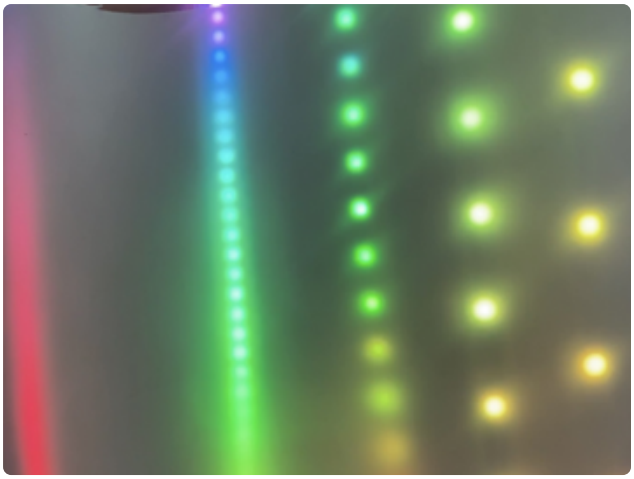
Lining Fabric

This is a white lining fabric I found at my local fabric store for around $2/yard. It's really lightweight and very inexpensive. With a little bit of distance it does a great job of diffusing the lights, at a very nice price.



Mesh / Tulle

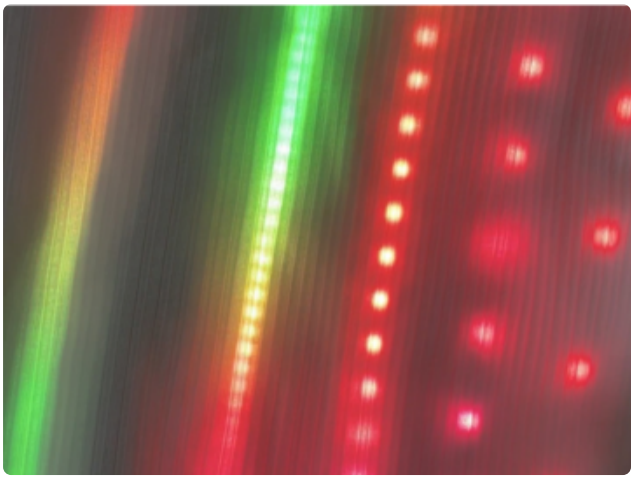
White mesh is really inexpensive and easy to find. Depending on the density of the weave, it may or may not diffuse your LEDs much. It gets a bit more interesting with some distance - the polyester fibers get a bit shiny and give a silvery look when it's a few inches away. Enough light sneaks through the holes in this fabric that the reflective properties carry through a bit to the viewer. Mesh is really inexpensive - you can find it for around $2-3/yard at just about any fabric store.

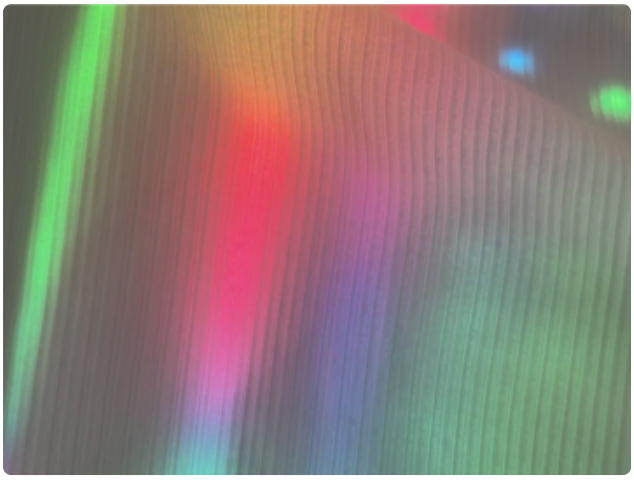


Neoprene Scuba Fabric

This is a lightweight 2mil neoprene fabric. It's smooth and stretchy, almost like a really thick spandex. This fabric is a mid-priced option at around $11/yard. It's wonderful to work with and stands up to a lot of stretching. It's also really warm. I think it diffuses the lights really well also.

Find it at Fabric Wholesale Direct (https://adafru.it/18Bz)



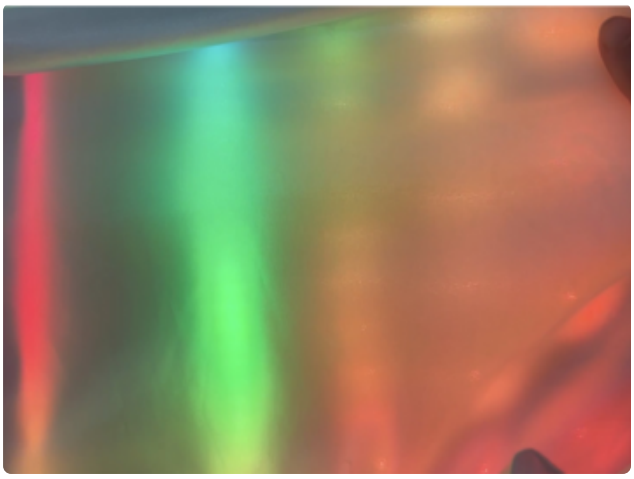


Rib Knit Cotton

This is a textured cotton fabric, often used for sleeve cuffs or other stretchy bits on clothing. It has thicker ribs and valleys that run along the weft of the fabric. I found it for around $5/yard at a local fabric store.

It makes a pretty interesting texture and emphasizes the animation a bit when it's aligned with the LED strips.

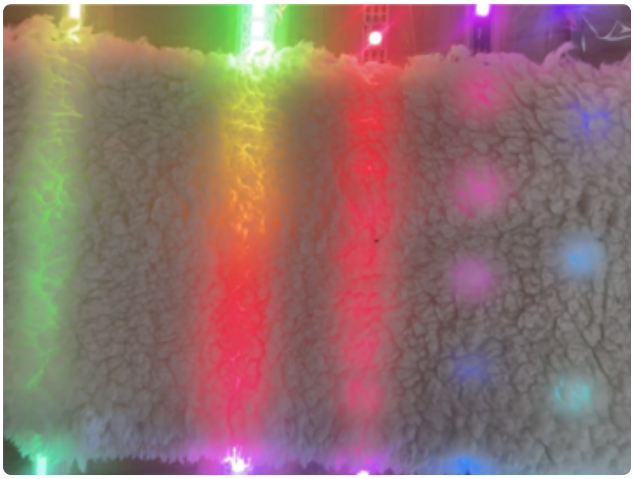
Rib Knit on Moodfabrics (https://adafru.it/18BB)

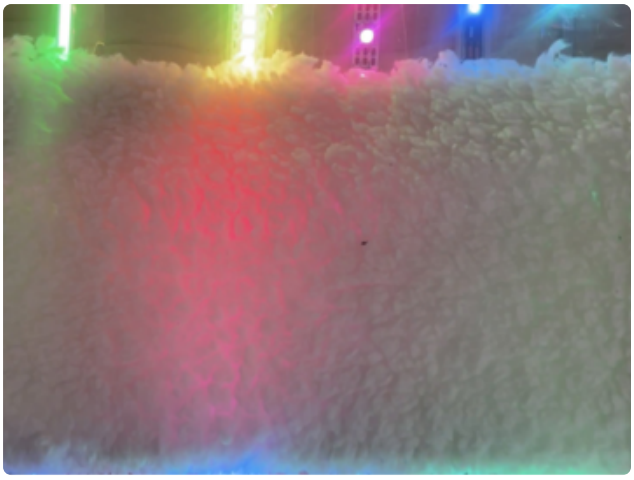


White Satin

This is a lightweight white satin fabric. It is shiny and diffus-ey and absolutely fabulous. Satin comes in a lot of different weights, from super thin satiny lining fabric which is almost translucent, and $2-3/yard, to heavyweight bridal satin, which is much more expensive and heavy and opaque and won't pass much light through at all. Test your strips before you make your choice, but you'll probably be really happy with satin as a diffuser. The shininess of the fabric picks up the lights and gives a lovely soft look.

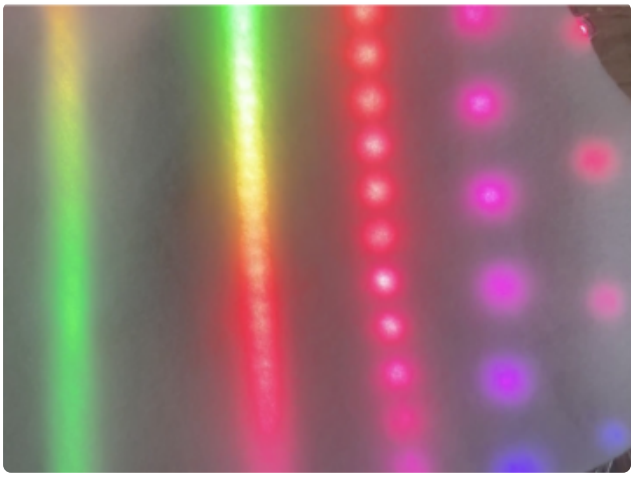
Medium weight satin from Amazon (https://adafru.it/18BD)





Faux Sheepskin

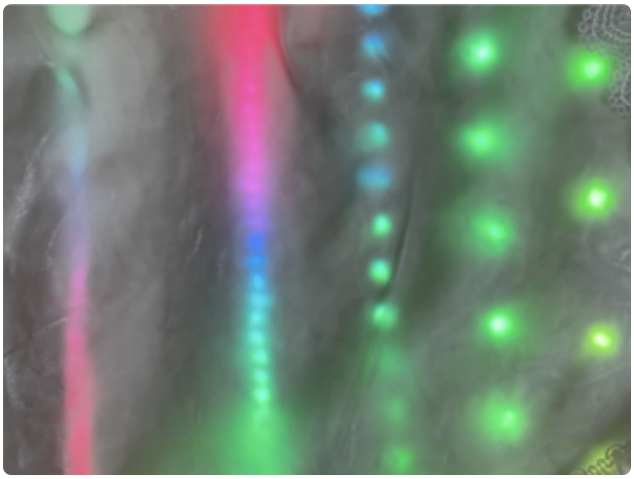
This is a lightweight white faux sheepskin fabric. It's nice and soft, but it's a little to heavyweight to pass much light through. Even at a couple inches away the light starts to get blocked by the fur. It does look pretty good when it's touching the strips directly, but .. not my favorite.

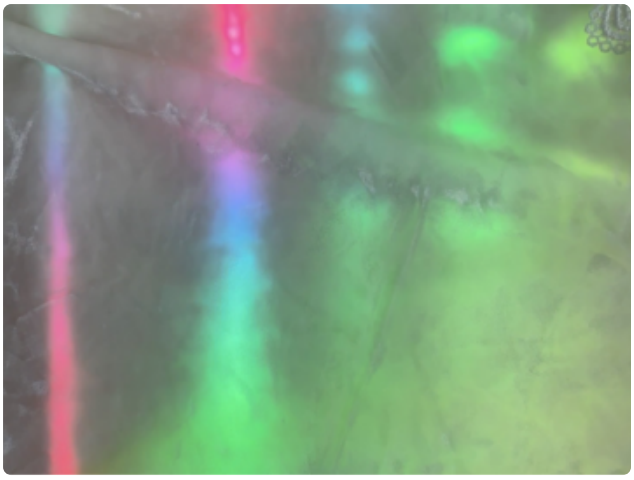


Fosshape / Felt

White felt is another great option. You can find it in varying thicknesses at any craft or fabric store and it does a nice job of diffusing the pixels with a bit of a fuzzy texture.

Fosshape (https://adafru.it/19Fn) is a nifty heat-reactive material that's basically a thermoplastic felt. When you heat it, it shrinks a bit an hardens to retain its shape. It's a really cool material choice for hats or other "stiff" costume pieces.





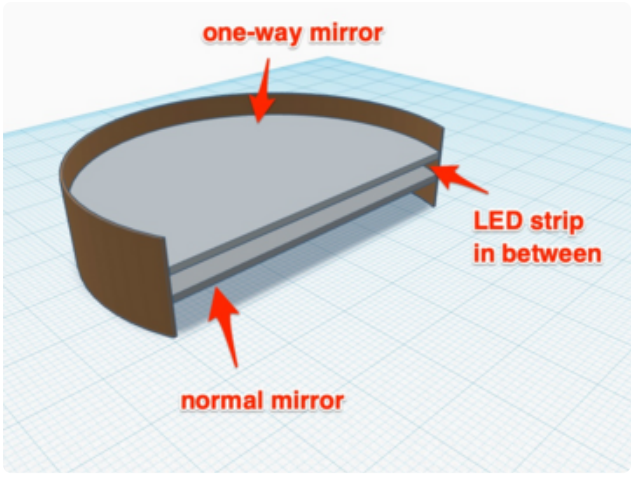
Velvet

This is a fairly heavyweight velvet fabric. Actually, it's my wedding dress - see, I knew I'd use it again one day! The heavy velvet blocks a fair amount of light, but with a little bit of distance it does make for some nice diffusion.

Infinity Mirrors

Acrylic One-way Mirror

One-way mirrors are nifty. They are see-through from the darker side but reflective from the lighter side. This is a piece of 1/8" thick acrylic mirror from Amazon. The distance doesn't make much of a difference with an acrylic mirror - the diffusion is fairly light and doesn't change much.

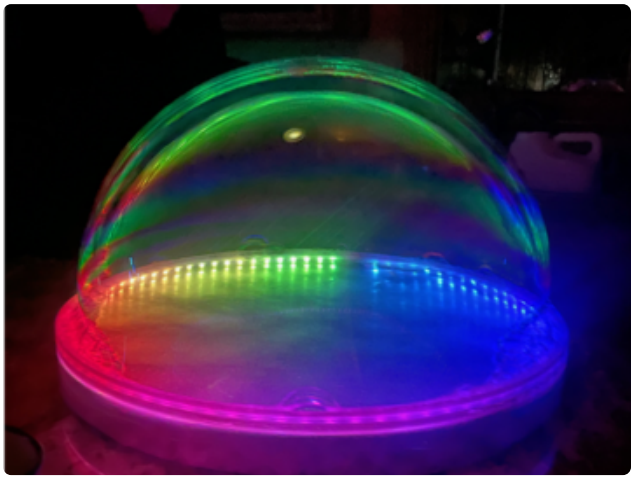


My favorite reason to use one-way mirrors as diffusors is to build an infinity mirror. Infinity mirror projects are a lot of fun. The way they work is illustrated in the graphic. An LED strip sandwiched between a one-way mirror and a regular mirror will reflect the lights back and forth and make the lights appear to reflect into infinity. The one-way mirror allows you to see through and enjoy the endless reflections.

Here are a few sample projects that use infinity mirrors.

Infinity Mirror Coaster (https://adafru.it/18BJ)

Infinity Mirror Collar (https://adafru.it/18BL)



Bubble Table with LED animations and IR Control (https://adafru.it/18BM)

Pre-Diffused Strips

Adafruit sells a few different pre-diffused NeoPixel "neon" strips. If you're looking for a solid bar of light, these are a good option. The strips are encased in a solid chunk of silicone. They're flexible and bendy from side-to-side, which is something that standard NeoPixel strips can't do.

These are great for making neon signs, stick-person costumes, or any project where you want a solid diffused bar of light.

NeoPixel RGB Neon-like LED Flex Strip with Silicone Tube

No joke, we have been looking for this exact product for over 5 years, and we've finally got the perfect one in stock! You love NeoPixels, and you love silicone diffusion? Peep...
https://www.adafruit.com/product/3869

Flexible Silicone Neon-like Skinny NeoPixel LED Strip

You love NeoPixels, and you love silicone diffusion? Peep this Flexible Silicone Neon-like Skinny NeoPixel LED Strip! OK it's a bit of a mouthful, but check...
https://www.adafruit.com/product/4310

Ideas for Use

LED Neon Signs with NeoPixels (https://adafru.it/18BN)

Stick Person Costume with LED Strips (https://adafru.it/18BO)

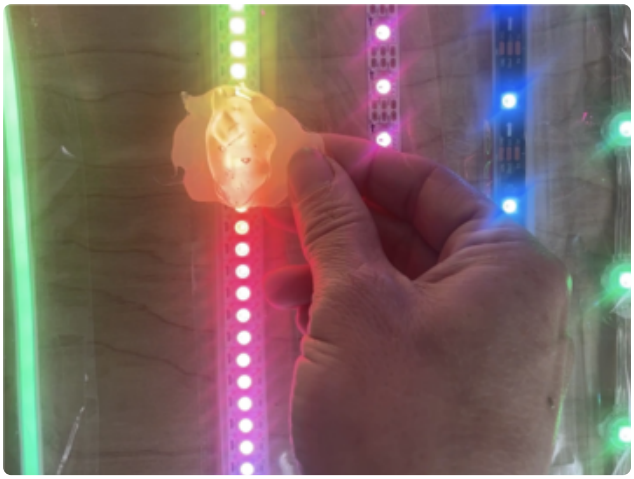
LED Neon Selfie Spot (https://adafru.it/18BP)

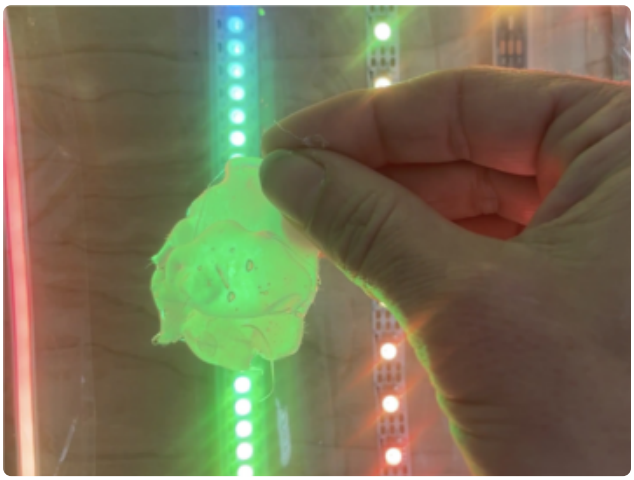
NeoPixel Mickey Ears (https://adafru.it/Kcd)

Other Ideas

Webbing

This is 1" tubular polyester webbing from Strapworks (https://adafru.it/18BR). It's less than $1/foot and the NeoPixel strips fit really nicely inside. The diffusion is pretty good, especially for such a tight envelope, and it's really easy to work with.





Hot Glue

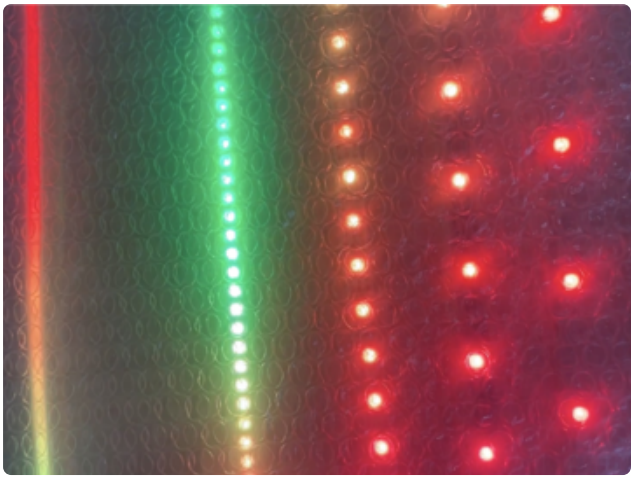
Hot glue is one of my favorite materials. You can squeeze it into a silicone mold or onto some clear packing tape and it will peel off in a single piece. It diffuses light really well and can be shaped into all kinds of different forms. If you get it stuck to something accidentally, use 99% isopropyl alcohol to release it and end up with a piece of custom-molded plastic that you can re-melt and re-form as much as you'd like.

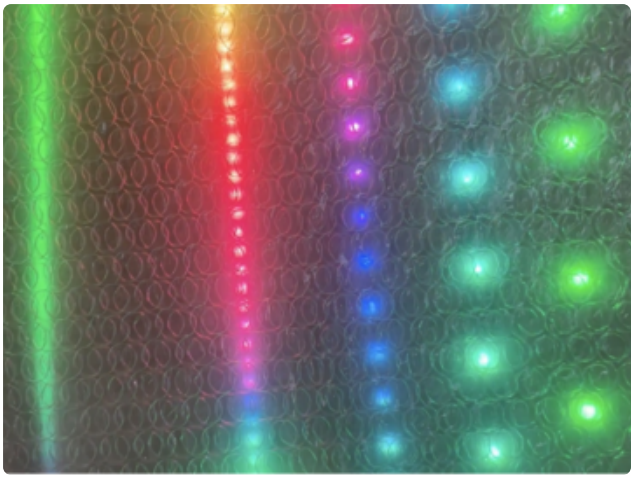
Polyester Fiberfill

Also known as pillow stuffing, this stuff makes a great diffusion material. This is great for making clouds or other nebulous amorphous shapes with lights behind, and you can keep adding thickness until you're really happy with the amount of diffusion.

Polyester fiberfill on Amazon (https://adafru.it/18BT)

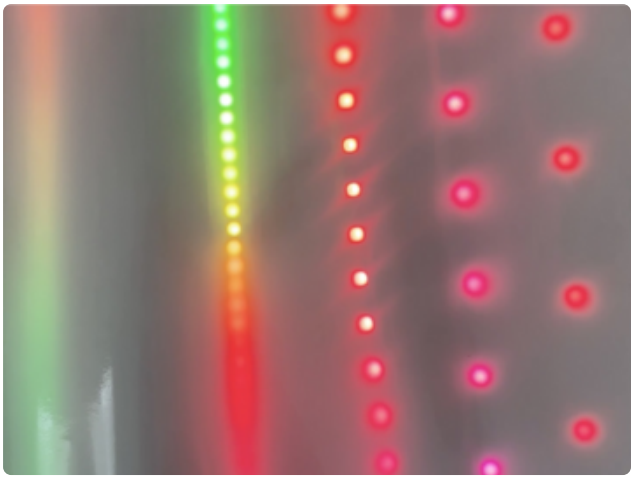
You can also scrounge this material from old pillows.

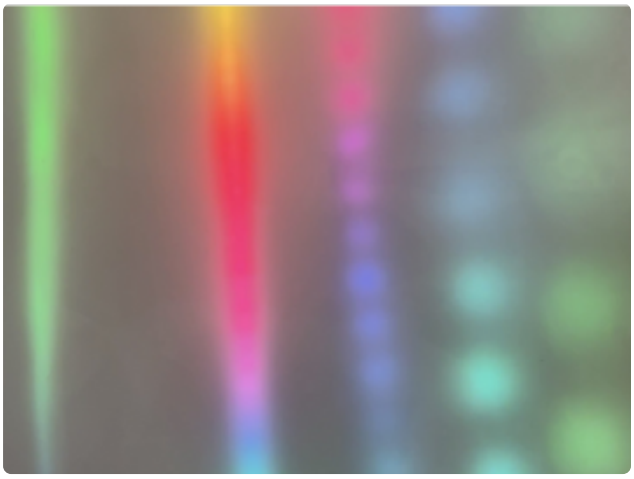




Bubble Wrap

Easy to get your hands on, bubble wrap does some subtle diffusion. And, it protects your artwork from smashing!





Cricut Vinyl

Many craft stores carry lots of vinyl sticker paper, made for cutting in Cricut or Silhouette cutting machines. The white vinyl is fairly opaque but still transfers light through pretty well. Using Cricut-cuttable materials opens up a whole world of project possibilities, and there are endless varieties of material available both online and in almost any brick-and-mortar craft store.

This stuff is already sticky on the back, but won't stick very well to the silicone sleeve that a lot of pixels come protected in. Hardly anything sticks to silicone, so take that into account if you're planning a vinyl sticker project.

Have more ideas? Share them with us in the Adafruit Discord Community () and help inspire other makers.