Denver Mask Task Force: DIY Face Mask Materials Guidelines

The following are guidelines for DIY facemask construction that have been recommended by the Denver Mask Task Force, based on research and recommendations from health care providers. Remember that wearing a DIY facemask is irrelevant if you do not also follow CDC recommendations to practice social distancing (6 feet at all times, even family), wash hands frequently and thoroughly, avoid touching nose, eyes, and mouth, and sanitize surfaces frequently.

Which pattern does DMTF recommend?

1st Choice: Craft Passion with built in OlyFun Filter
http://www.craftpassion.com/?p=26304

WHY?
- 10+ years of 1st responder experience went into the design of this mask
- Approved by Multiple Hospitals in CO
- Lies flat for sterilization in an auto-clave
- Fits Close to Face (simulating N95 mask design)
- Does not Need a metal clip for nose
- Fewer Materials → Fast Production

2nd Choice: Pocket Mask
https://www.youtube.com/watch?v=tDt02kUpP9Q&fbclid=IwAR0eXJht-WtCJZpRHtuXRHS2XXQ0-VLiDfMI3rB0ff9w4duYKQHZIcono0&app=desktop

3rd Choice: Cotton Mask, No Filter. Favorite Pattern Coming Soon!

Do you accept other patterns and materials?
Yes. We will match donated masks according to the needs of different providers and donate them accordingly. For example, 100% fabric masks are not ideal for medical environments if alternatives are available, but we may be able to trade them to a veterinary clinic in exchange for higher grade medical masks or medical providers can wear them over N95 masks when they are asked to re-wear masks throughout their shifts.

What kind of materials does DMTF recommend?

1st Choice:
- Outer layer: 100% cotton or cotton polyester blend in a different color than the inner layer
- Double layer filter sewn into mask: Olyfun brand non-woven 100% polypropylene
- Inner layer: 100% cotton or cotton polyester blend in a light color
2\textsuperscript{nd} Choice: (Disposable Filter)
- Outer layer: 100% cotton or cotton polyester blend in a different color than the inner layer
- Removable filter: Vacuum cleaner bag (these filters are not washable so they are suitable for pocket mask design only)
- Inner layer: 100% cotton or cotton polyester blend in a light color

2\textsuperscript{nd} Choice: (Reusable Filter)
- Outer layer: 100% cotton or cotton polyester blend in a different color than the inner layer
- Filter: OlyFun tack in place, does not need to be removable because the filter can go through the sterilization process with the mask.
- Inner layer: 100% cotton or cotton polyester blend in a light color

3\textsuperscript{rd} Choice:
- Outer layer: Cotton Polyester blend in a different color than the inner layer
- Inner layer: Cotton Polyester blend in a light color

**What kind of elastic should I use?**

1\textsuperscript{st} choice: \(\frac{1}{4}\) inch flat elastic or cord elastic
2\textsuperscript{nd} choice: thicker braided elastic cut into \(\frac{1}{4}\) inch strips (note that woven elastic will fray more than braided and should be cauterized by quickly running it over a candle flame or using fray check on the exposed edge)
3\textsuperscript{rd} choice: hair ties, \(\frac{1}{4}\) inch sport head bands, any other elastic that is comfortable behind the ears or behind the head and can be washed and dried on high heat.

DO NOT USE if donating: rubber bands, super thin elastic that will cut into the skin, swimsuit material

**What if I can’t find elastic?**

Use or make cotton strips called **bias tape**. Bias tape is a strip cut out of woven fabric (like quilting cotton) diagonally so that it has a little bit of stretch. These are NOT used as elastic, rather in long strips to tie in a bow. Search for YouTube tutorials for “Double fold bias tape”. A bias tape maker can be purchased for less than $10. You can also use shoelaces, ribbon, or other materials that tie comfortably behind the head and can be washed and dried at high heat. Be sure to secure the end so that the ties do not fray.

**Why is cotton and cotton/polyester blend the preferred fabric?**

This comes from a 2013 study from the University of Oxford called “Testing the Efficacy of Homemade Masks: Would They Protect in an Influenza Pandemic?” It found that cotton blend fabric masks (woven) blocked about 70% of bacteriophage MS2 virus particles, which is similar in size to COVID-19 particles.
TABLE 1

Filtration Efficiency and Pressure Drop Across Materials Tested with Aerosols of *Bacillus atrophaeus* and Bacteriophage MS2 (30L/min)*

<table>
<thead>
<tr>
<th>Material</th>
<th><em>B. atrophaeus</em></th>
<th>SD</th>
<th><em>Bacteriophage MS2</em></th>
<th>SD</th>
<th>Pressure Drop Across Fabric</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% cotton T-shirt</td>
<td>69.42 (70.66)</td>
<td>10.53 (6.83)</td>
<td>50.85</td>
<td>16.81</td>
<td>4.29 (5.13)</td>
</tr>
<tr>
<td>Scarf</td>
<td>62.30</td>
<td>4.44</td>
<td>48.87</td>
<td>19.77</td>
<td>4.36 (0.19)</td>
</tr>
<tr>
<td>Tea towel</td>
<td>83.24 (96.71)</td>
<td>7.81 (8.73)</td>
<td>72.46</td>
<td>22.60</td>
<td>7.23 (12.10)</td>
</tr>
<tr>
<td>Pillowcase</td>
<td>61.28 (62.38)</td>
<td>4.91 (8.73)</td>
<td>57.13</td>
<td>10.55</td>
<td>3.88 (5.50)</td>
</tr>
<tr>
<td>Antimicrobial Pillowcase</td>
<td>65.62</td>
<td>7.64</td>
<td>68.90</td>
<td>7.44</td>
<td>6.11 (0.35)</td>
</tr>
<tr>
<td>Surgical mask</td>
<td>96.35</td>
<td>0.68</td>
<td>89.52</td>
<td>2.65</td>
<td>5.23 (0.15)</td>
</tr>
<tr>
<td>Vacuum cleaner bag</td>
<td>94.35</td>
<td>0.74</td>
<td>85.95</td>
<td>1.55</td>
<td>10.18 (0.32)</td>
</tr>
<tr>
<td>Cotton mix</td>
<td>74.60</td>
<td>11.17</td>
<td>70.24</td>
<td>0.08</td>
<td>6.18 (0.48)</td>
</tr>
<tr>
<td>Linen</td>
<td>60.00</td>
<td>11.18</td>
<td>61.67</td>
<td>2.41</td>
<td>4.50 (0.19)</td>
</tr>
<tr>
<td>Silk</td>
<td>58.00</td>
<td>2.75</td>
<td>54.32</td>
<td>29.49</td>
<td>4.57 (0.31)</td>
</tr>
</tbody>
</table>

* Numbers in parentheses refer to the results from 2 layers of fabric.

Source:
https://www.researchgate.net/publication/258525804_Testing_the_Efficacy_of_Homemade_Masks_Would_They_Protect_in_an_Influenza_Pandemic

Davies, Anna & Thompson, Katy-Anne & Giri, Karthika & Kafatos, George & Walker, James & Bennett, Allan. (2013). Testing the Efficacy of Homemade Masks: Would They Protect in an Influenza Pandemic?. Disaster medicine and public health preparedness. 7. 413-418. 10.1017/dmp.2013.43.
**Why does the color of the fabric matter?**
Using a lighter colored fabric on the inside of the mask allows folks to see more easily if the mask needs to be washed. Contrasting outer and inner fabric helps indicate which side has touched your face so that it can be used the same way every time.

**What does it mean for fabric to have a “tight weave”?**
Woven fabric is a grid of threads that run horizontally and vertically. The weave refers to how tight these threads are, or how much space is between them. If you hold woven fabrics up to the light, you will see a grid of pinprick dots. The smaller these dots are, the tighter the weave. The tighter the weave, the more large droplet particles (like from sneezing) will be prevented from passing through. **Thread count** in sheets refers to the number of threads that run in one direction per square inch. The higher the thread count, the tighter the weave.

**What does non-woven mean?**
Non-woven fabric, unlike woven and knit fabrics, is not created using threads on a loom. It is created by spraying fibers (natural or synthetic) at a surface so that they are evenly distributed, and then fusing them together with heat and or chemicals. When you hold non-woven fabric up to the light, you will not see continuous vertical and horizontal threads, and you should not see pinprick holes that go all the way through the fabric. There are still “holes” in the fabric that allow air and/or light to pass through, but they are too small for the eye to distinguish. Non-woven materials create a better filter than woven materials for this reason, because the size of the particles that are able to pass through is smaller. Non-woven fabric may be printed with a pattern or unprinted, in which case you should see lot of little fibers if you hold it up to the light.

**What is polypropylene?**
Technically, polypropylene is a thermoplastic polymer. In simpler terms, when sprayed into nonwoven sheets, it acts like a hybrid of fabric and plastic. It is highly durable and won’t tear, crack, fray or disintegrate in a washing machine. It has moisture-wicking/water repellant properties, which helps repel airborne saliva droplets like those from coughs and sneezes, and prevent the inside of masks from becoming moist. For example, it is often used in diapers to keep moisture from remaining in contact with the baby’s skin and causing rashes. It has a melting point of 320 degrees Fahrenheit, which allows to be safely used in most autoclave sterilization machines that rely on heat to sterilize. It has a low UV resistance, which means it
degrades faster when exposed to sunlight or UV rays. For use in UV sterilization machines, it should be covered with another fabric like cotton to protect it from degradation. If worn outside, it should also be covered with fabric to protect it from the sun. It is used in N95 masks as an internal filter between layers of high-tech polyester.

(Note: just because you are using polypropylene as a filter does not mean your mask is as effective as an N-95 respirator. Not even close. The effectiveness of an N-95 is due to a number of factors: the tight seal it creates around the nose and mouth, hydrophilic plastic coating on the outside of the mask, stringent fit testing, and a high-tech polypropylene filter that is treated with copper and zinc ions. Source: https://www.accessdata.fda.gov/cdrh_docs/pdf12/K122702.pdf)

Why is moisture retention a big deal with face masks?
Moisture retention is one of the main concerns with 100% fabric masks, because moisture droplets containing the virus can get trapped inside the mask and accumulate on the skin around the mouth. If the person wearing the mask then touches their mouth while removing the mask, the virus can spread. (This issue also exists when medical professionals are asked to continue wearing surgical masks that have become moist from prolonged use.) Masks with a moisture-wicking filter like polypropylene help to mitigate this issue. Like Gore-Tex or other high-tech sport wear designed to prevent sweat accumulation, it wicks moisture away from the mouth so that it does not remain in contact with the face.

Why is Olyfun the preferred brand of Polypropylene?
Olyfun is a type of nonwoven polypropylene fabric that is available in many fabric stores. It is also the preferred brand for many kinds of reusable shopping bags and promotional swag bags because it is really cheap, so you may already have some at your house. Olyfun is currently
being tested by National Jewish hospital to determine/confirm that it can filter particles down to .5 microns in size (not yet confirmed).

Where can I find Olyfun?
Call your local fabric store and ask if they have Olyfun fabric. Walmart also stocks it, and it can be found on amazon or at this link: https://www.fairfieldworld.com/olyfun/. If you are in the Denver area, you can also reach out to our Donor Captain, Natasha Chornomqz (contact info available in the google sheet for group members).

Can I use reusable grocery bags, landscaping fabric, or other kinds of polypropylene?
Maybe. Go through these steps to check whether a fabric you have on hand can be used as a filter:

1) Do your best to confirm that it is 100% polypropylene. Check the label, or google the manufacturer. Look for the words 100% polypropylene, spunbond polypropylene, or meltblown polypropylene.

2) Only use nonwoven fabric. There are some kinds of polypropylene that are spun into threads and woven. Hold a piece of the fabric up to the light. If you see a pinprick pattern of light dots and a grid of horizontal and vertical strands, it is woven. If you can see dots of light, these are holes through which larger particles will be able to pass.

3) Do not use polypropylene that is shiny on one side and fabric-like on the other. Only use the kind that is more like fabric on both sides. Many reusable shopping bags have a shiny coating on one side.

4) If you want to be extra sure, test the fabric at high heat, such as boiling it or putting it in the dryer on high heat. If you have access to an autoclave, try putting it in with a cotton cover to protect it from UV degradation. Make sure that it does not burn, melt, smell like burning plastic, or distort in shape.

How many layers of polypropylene should I use?
If using Olyfun, we recommend two layers. For other kinds of polypropylene, layer the fabric until minimal light comes through when you hold it up to a lightbulb. Confirm that you can still breathe easily through all of the layers, plus two layers of cotton or cotton/polyester blend.

Can I use interfacing or quilt backing as a filter?
Maybe. Most interfacing is nonwoven fabric, giving it better filtration than woven cotton. However, most interfacing is made of polyester, which does not have the same moisture-wicking properties as polypropylene. Some kinds of interfacing are made of other synthetic fabrics like viscose, which can melt, burn, or catch fire at high heat. Do not use interfacing if you cannot confirm that it is 100% polyester. Iron-on interfacing should be ironed
to the mask fabric first to prevent distortion at high heat. Double check that you can still breathe through the ironed-on filter. Thinner kinds of interfacing may also be used for making single use surgical caps, one layer without cotton.

These materials have been tested and won't combust during an autoclave high-heat sterilization process.
- Pellon Shirt Tailor 950F
- Cambrica Interfacing.

Is a vacuum cleaner bag the preferred insert filter for pocket masks?
**PROS:** Research on the efficacy of vacuum bags as a filter comes from the 2013 study from the University of Cambridge (see above). Vacuum cleaner bags typically are either a single non-woven paper-like fiber layer or a double layer of paper-like fiber plus a layer of non-woven synthetic fabric. This could be polypropylene, or polyester, or another synthetic. It was not indicated in the study what kind of vacuum cleaner bag was used, but one can assume that the most effective type would be the kind with a double layer. Vacuum cleaner bags can be cut easily to be used as inserts for pocket filter masks.

**CONS:** The filter cannot be sterilized & should be discarded after each use.

Can I just make a mask entirely out of vacuum cleaner bag?
There are several reasons to hesitate when making pure vacuum cleaner bag masks. Paper fibers cannot get wet and will not stand up to high heat during washing or sterilization. This means vacuum cleaner bags can only be used once unless you have access to a UV sterilization machine that does not require water, soap, or heat. This also means you typically can’t wash or sterilize them before giving them to another person. Therefore this type of mask is not suitable for donation because we cannot ensure that it was made under sterile conditions and it cannot be sterilized. The stiff nature of a vacuum cleaner bag may also make the mask wearer more likely to touch their face while readjusting the mask, potentially aiding the spread of the virus. You can make this kind of mask, but be aware of its limitations.

Should I use wire or pipe cleaner along the nose?
The point of adding wire to a mask is to increase the tightness of the fit to the face, decreasing air space for particles to enter. If using a pattern that has a rounded cut like our top choice pattern, this will add minimal extra contouring as the pattern is already designed to fit more closely to the face than a rectangular pattern. You might consider adding wire or pipe cleaner to rectangular mask patterns to improve the fit of the mask. You can do this by inserting the wire after you have turned the seam right side out, and then sewing an additional line of thread
beneath the wire and to the sides to secure it in place. Another way to achieve a tighter fit to the face is to add double folded darts at the nose and chin of the mask, like this:

**Note that you will need to increase the length of elastic in a rectangular pattern so that it doesn’t sit too tightly on the ears. If you want to add darts to masks that have already been made, double check that it doesn’t make the elastic too tight.**

**Washing/Sterilizing Instructions**

**Autoclave Sterilization:** The melting point for our polypropylene filter is 320°F. Standard operating temperature for Heat Autoclaves is 250°F. We recommend masks be double bagged, freestanding on stainless tray with minimal water added. If your mask includes elastic straps, they may not withstand autoclave sterilization. The WHO recommends heating to greater than 212°F for 2 min.

**Home Sterilizing Instructions:**
Oly-fun filter material should not be soaked long term in water. You can wash gently and air dry. The preferred method to sterilize them is to put them inside a freezer-weight Ziploc and drop them in a pot of boiling water for 15+ minutes. Instapot instructs to place items in silicone/metal steamer, on steam function with 750ml water. Newer models have dedicated sanitize button.

**Home Washing Instructions (for personal use)**
Gentle Wash & Air Dry - in this case, soap rather than heat is used to remove the virus from the fabric.

**DISCLAIMER:** This face mask is not meant to replace the surgical face mask, it is a contingency plan for those who have no avail to surgical mask in the market or as a second layer of protection for those being asked to re-use surgical and/or N95 masks with multiple patients. Proper use of a surgical mask and/or N95 mask is still the best way to prevent virus infection.

We are committed to providing the most accurate and up-to-date information as it becomes available. If you have research for us to review or a suggested update, please email us at DenverMaskTaskForce@Gmail.com