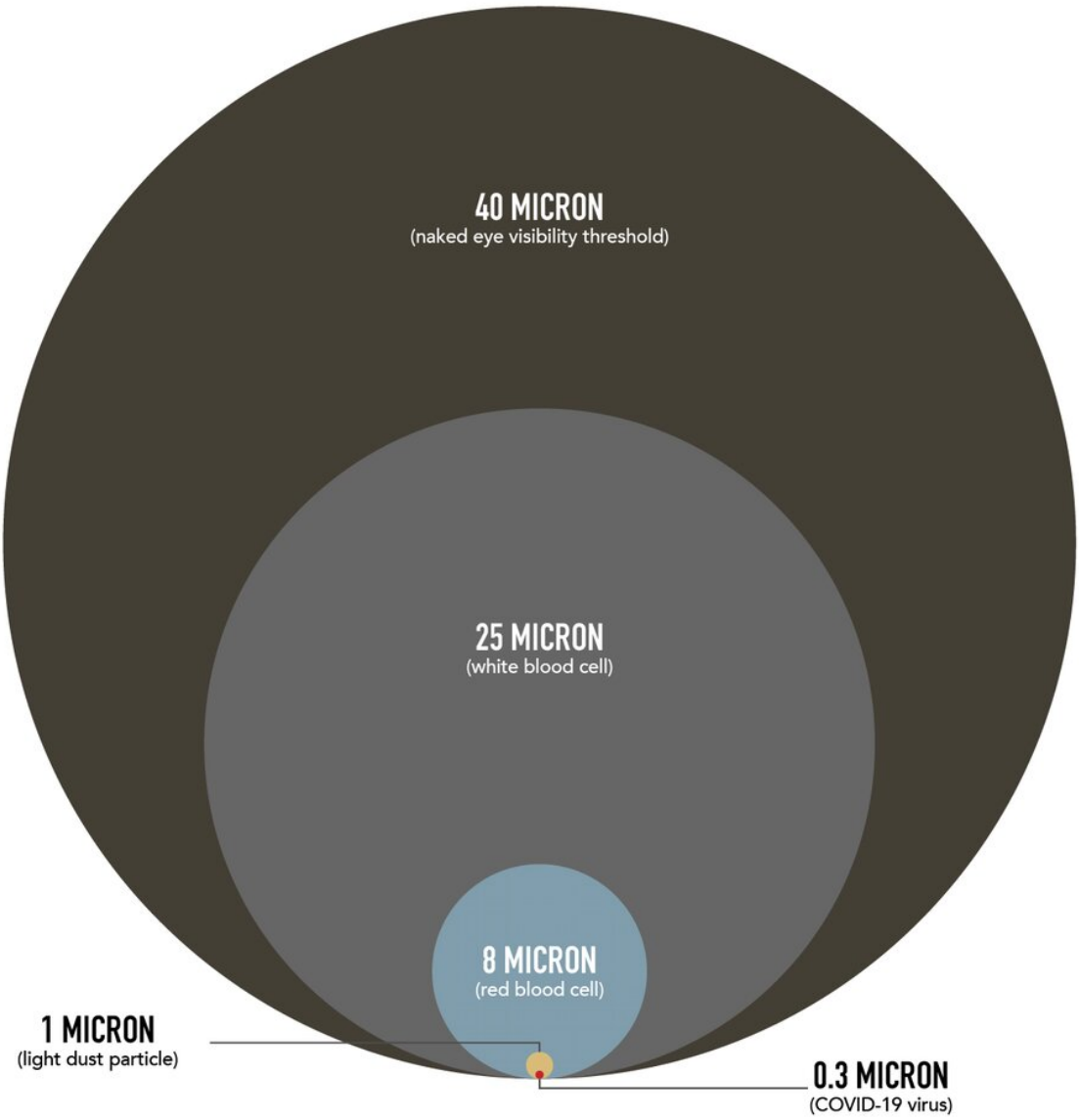
Making masks at home – what you need to know about how to reduce the transmission of coronavirus

April 16 2020, by Susan L. Sokolowski and Karen L. Labat



SARS-CoV-2 virus in comparison to other known particles (not to scale). Credit: Susan Sokolowski, CC BY

The recent Centers for Disease Control and Prevention recommendation to use cloth face coverings to help slow the spread of COVID-19 has generated numerous how-to articles and videos. As academics who focus on personal protective equipment (PPE) research and development, we are concerned about the lack of information about two critical features of home mask design: fit and fabric selection.

The reality of particle size

Virus particles are tiny, ranging from 0.1 to 0.3 micron. A size 40 micron particle is visible with the naked eye—anything smaller, you need specialized equipment to see it.

Protective masks like the N95 are designed to prevent virus particles from flowing in and out of the mask. Due to current shortages, N95 masks should be reserved for COVID-19 health care workers only.

Better than nothing

Homemade masks cannot block or filter the SARS-CoV-2 virus, because it can easily flow through every common material people have at home. However, a homemade mask is still better than none at all. If made correctly, a homemade mask can reduce the transmission of the virus from the wearer to others by impeding large droplets and spray produced by a cough or sneeze. It can also reduce the transmission of the virus from others to the wearer.

Fit

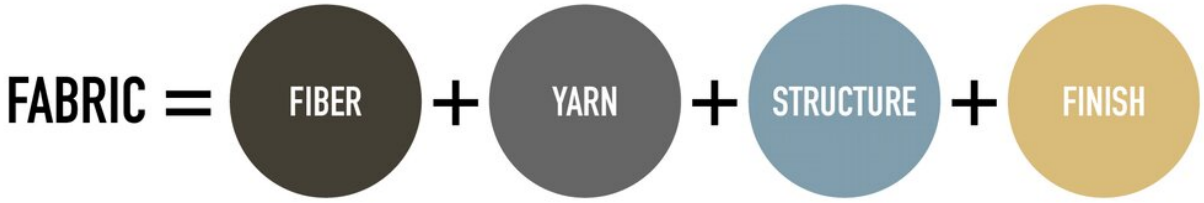
Masks should completely cover the nose and mouth. When measuring for a mask pattern, make sure it extends from the top of the nose—as close as possible to the eyes without obstructing sight—to under the chin. Masks should cover the face side-to-side, well past the opening of the mouth.

A properly fitting mask. Credit: Arlys Dayton, CC BY

When developing prototypes, check around all edges of the mask for gaps. If you see any, close them up by pinching the fabric together, and stitch or tape or staple edges together to create a pleat or dart. A thin metal wire or paper clip placed along the top edge of the mask can stabilize and shape it along the bridge of the nose and cheekbone for a closer fit.

Masks should stay securely in position and fit comfortably with ties or elastic ear loops. If the mask is too tight or loose, the wearer may continuously adjust the mask forgetting the admonition—"Don't touch your face!"

The ties and loops should also be the mechanism for taking off the mask, as the front of the mask might be contaminated.



Variables that make up a fabric. Credit: Susan L. Sokolowski and Karen L. LaBat, CC BY

Fabric selection

People have varying access to different fabrics at home. Masks should incorporate fabrics that:

- Reduce virus transmission to and from the nose and mouth
- Wrap around the face and are comfortable next to the skin
- Are easy to wash and sanitize.

Fabric is comprised of four variables that must be considered for mask making: fiber, yarn, structure and finish. Change a variable—and mask performance changes.

Fibers are the smallest component of a fabric. They cannot be identified by sight or touch. Look for a fiber content label on the products or fabrics you might use for your mask. Alternately, a "burn test" can be used as a crude method to determine if a fabric is a natural fiber, human-made fiber, or a blend of natural and man made fibers. If you choose this method be careful.

There are three important fiber characteristics to consider for mask making. The first is micron size—the diameter of a fiber. The SARS-CoV-2 virus particle is 0.1 to 0.3 micron, so small-sized fibers allow for more compact fabric structures to reduce transmission. The second is how the fiber feels next to skin—this will indicate how comfortable a mask may feel next to your face. The third is moisture regain—how well the fiber absorbs moisture. A higher number means more absorbency; low regain gives a sense of how well the fiber might repel moisture.

FIBER NAME & PRODUCT TYPES	MICRON SIZE	NEXT TO SKIN FEEL	MOISTURE REGAIN	MASK CONSIDERATIONS
Cotton (T-shirts, denim jeans, bedding, bandanas)	11-22μ	Soft, limited allergic reactions	7-11%	Absorbent, easy wash & dry at high temps, not damaged by detergents or bleach
Flax/linen (dresses, shirts, suiting)	12-16μ	Can be scratchy, limited allergic reactions/irritations	12%	Softens over time, wrinkles, absorbent, may shrink when washing & drying at high temps, not damaged by detergents, bleach weakens
Wool (sportswear, dresses, suits, coats)	11.5-14μ	Can be scratchy, possible allergic reactions/irritations	13-18%	Absorbent, insulating, not damaged by detergents, bleach damages, may "felt" with high temp washing/drying
Silk (shirts, dresses, suits, ties)	10-13μ	Smooth, soft, no allergic reactions	11%	Absorbent, use mild soap, bleach damages, cannot wash/dry at high temps
Rayon (dresses, shirts, pants)	Varies	Smooth or textured, limited allergic reactions	11.5-12.5%	Absorbent, use mild soap, bleach damages, cannot wash/dry at high temps, may shrink
Polyester (sportswear, dresses, pants, shirts, jackets)	Varies	Smooth or textured, limited allergic reactions	0.4%	Non-absorbent, dries quickly, high strength, not damaged by detergents, bleach weakens, retains odor
Nylon (sportswear, underwear, bags)	Varies	Smooth or textured, limited allergic reactions	2.8-5%	Low moisture absorption, high strength, not damaged by detergents, bleach weakens
Polypropylene/ olefin (sportswear and, medical apparel)	Varies	Smooth or textured, limited allergic reactions	Less than 0.1%	Does not absorb moisture or odor, dries quickly, wicks moisture, oily stains difficult to remove, not damaged by detergents, bleach weakens
Spandex (sportswear apparel, underwear, pants, shirts)	Varies	Smooth, limited allergic reactions	.75-1.3%	Low moisture absorption, stretchy, resists body/make-up oils, not damaged by detergents, bleach weakens

Generic fiber characteristics and mask considerations. Credit: Susan L. Sokolowski and Karen L. LaBat, CC BY

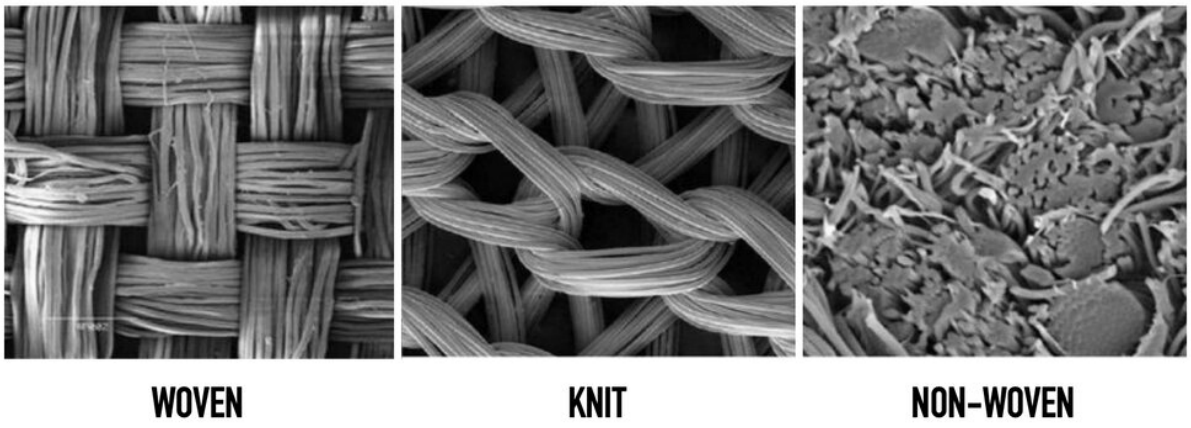
Fibers are twisted together to form yarns. Yarns vary in size affecting fabric thickness and breathability. "Yarn count" is the number of yarns in a 1-inch square of woven fabric. A high yarn count fabric indicates a dense fabric with droplet blocking potential. Yarns with different properties can be blended to combine characteristics.

Yarns are then structured into the physical fabric.

Performance finishes, like water repellency and antimicrobials, are not visible but could be helpful. Detect water repellency or moisture wicking by using an eye dropper to place a drop of water on a fabric to see how it moves across the fabric. Aesthetic finishes like graphics and batik are not so useful.

Put it all together

There are many fabric variables to reckon with for a homemade mask. Consider building a three-layer system.



Types of fabric. Credit: Susan L. Sokolowski and Karen L. LaBat, CC BY

STRUCTURE & PRODUCT TYPES	CONSIDERATIONS RELATED TO MASK DESIGN
Woven (denim jeans, shirting, bedding)	Woven fabrics are fairly stable - so the mask will not stretch. Openings between the yarns can allow droplets/vapor to transmit through the fabric, so select a fabric with small openings and/or high yarn count to limit transmission.
Knit (sportswear, underwear)	Knits are stretchy which can aid with mask comfort and fit, but the structure can distort when stretched across the face, creating open spaces allowing transmission.
Non-woven (coffee, furnace & vacuum bag filters)	The random non-woven structure may provide a blocking advantage, depending on how densely the yarns/fibers are packed. If the yarns/fibers are too compacted, they may impede breathing (e.g. plastic films). Nonwovens do not stretch in any direction - the fabric could rip if under too much tension. Avoid nonwovens of fiberglass.

Structures and mask considerations. Credit: Susan L. Sokolowski and Karen L. LaBat, CC BY

VARIABLE	NEXT TO FACE LAYER	REPLACEABLE MIDDLE LAYER	OUTSIDE LAYER (FACING THE ENVIRONMENT)
Fiber	Comfortable, non-allergic, absorbent, can wash/dry in high heat with detergent/bleach	Low-absorbent	Any fiber that can wash/dry in high heat with detergent/ bleach
Yarn	High yarn count	High yarn count	High yarn count
Structure	Compact knit or woven, breathable	Compact, non-woven filter, breathable	Compact woven, breathable
Finish	If available, use moisture management (wicking) finish	If available, use anti-microbial finish	NA

Three-layer mask system considerations. Credit: Susan L. Sokolowski and Karen L. LaBat, CC BY

This three-layer system includes a space between the inner and outer layers for a removable middle layer. A replaceable "filter" is inserted in that space. If one fabric layer is too thin, add additional layers for protection.

Homemade masks will not filter the SARS-CoV-2, however, masks may prevent droplets and spray from transmitting between individuals. When wearing a mask, remember to continue social distancing, wash hands frequently and wipe down surfaces and packages.

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