Cookbook for Protective Masks Against COVID-19

Level 0: General Guidance on DIY Cloth Masks

- Multi-layer cloth masks are more effective than single-layer masks

Level 1: Salt masks

Antiviral properties of salt: While table salt, NaCl, has been used as a surrogate particle to test the filtration efficiency of masks (REF), it has also been suggested as an antiviral agent itself. Wieringa-Jelsma *et al* showed that a combination of NaCl treatment and high temperature conditions deactivated certain animal viruses in a collagen matrix sausage casing with varying success (REF, REF). In 2017, Quan *et al* reported that a polypropylene microfiber filter coated with NaCl nanocrystals enabled deactivation of influenza virus, as well as higher survival rates of mice exposed to the virus through the salt-coated filter (REF). The proposed mechanism for deactivation was the interference of NaCl crystals with the structural integrity of the virus itself. While the experiment has not been reproduced to our knowledge with either influenza virus or SARS-CoV2, a recent study in the *American Journal of Infection Control* (REF) did demonstrate that NaCl-treated paper towels and surgical masks showed high enough filtration efficiency to prevent virus-sized particle transmission through a mask, as well as a reduction of bacterial (E.coli) growth underneath the mask. This study did not address the antiviral nature of NaCl crystals; however, Jeong *et al* in 2019 demonstrated that aerosol deposition of natural sea salt particles onto an air filter achieved 98% bactericidal efficiency using *Staphylococcus epidermidis* and *Escherichia coli* (REF). This literature suggests tentatively that NaCl possesses some antimicrobial, possibly even antiviral, properties. Since table salt is a common household item around the world and readily crystallizes on various surfaces, salt-coated masks offer a potentially semi-protective alternative to expensive or inaccessible masks.

Materials:

- Breathable fabric
- 2 teaspoons table salt (NaCl)
- ½ cup water, sterile
- Sterile container and utensils for mixing and measuring

Steps

1. Cut the size and dimension of fabric needed for the mask
2. Create a solution containing 2 teaspoons of table salt and ½ cup of water. Mix the solution thoroughly until all or most of the salt is dissolved.
3. Soak the fabric in the solution for a day, then hang the fabric to dry. The evaporation of water should allow salt crystals to grow on the fibers within the fabric.
4. Make cloth into fabric. If fabric ends up being too brittle, decrease the length of time taken for soaking (the crystals may be too large)

Level 2: Copper-embedded masks

Antiviral properties of copper: Although respiratory transmission is currently thought to be the main source of COVID-19 transmission (REF), very recent reports of transmission through airborne dust particles have come to light (REF). Copper is an undisputed antiviral agent, most recently against the SARS-CoV-2 virus (REF, REF, REF, REF). Copper has been recognized as a biocidal agent for millenia; Borkow reports a feasible home-based demonstration from the 18th century, which found that fungi could not grow on seeds soaked in copper sulphate (REF). Copper alloys were confirmed by the EPA as antimicrobial in 2008. This includes brass, an alloy of copper and zinc, and bronze, an alloy of copper, tin, and other elements. At the nanoscale, the exact mechanism of how copper deactivates viruses may involve more than one mechanism, which has previously been reviewed (REF, REF) Based on observing the deactivation of human coronavirus 229E (a respiratory viral surrogate for the SARS and MERS viruses) on copper/copper alloy surfaces, Warnes *et al* suggested in 2015 that copper or copper alloy surfaces be used in communal spaces to prevent contact transmission of respiratory viruses. The main challenge is developing a home-based procedure to synthesize a safe copper-based compound. Common copper compounds include copper sulphate, which is mildly toxic (REF), copper (ii) nitrate, which is classified as an irritant (REF), copper chloride, which is also toxic (REF), and copper carbonate, which is not classified as an irritant like the aforementioned, but is harmful if swallowed (REF). This suggests that the least harmful of these compounds should be tightly bound to fabric masks, which would likely require a commercial binding process, or that harmless copper-based materials such as pure copper or copper oxide should be used instead. It is also important that whichever material is used has a high enough concentration of copper to be lethal against SARS-CoV-2, but not so lethal as to harm the individual or restrict breathing (REF). The table below links a handful of commercial copper-embedded masks, not all of which have been tested to protect against SARS-CoV-2:

Company	Cost	Tested against SARS-CoV-2
American Giant	$25.00	Not recommended for medical use or near COVID-19 patients
Atoms Everyday	$12.00	Not tested against SARS-CoV-2 specifically
Bilio	$38.00	Not tested against SARS-CoV-2 specifically
Sonovia	$69.00	Tested against SARS-CoV-2

Suggested home-based chemical method (not tested or approved as anti-viral): This protocol is based on studies which synthesized copper nanoparticles using citric acid and heat (REF).

Materials:

- Breathable fabric, preferably synthetic or dyed, which contain chemical groups to facilitate copper binding
- 2 teaspoons table salt (NaCl)
- ½ cup distilled white vinegar
- 2 dimes or coins with high copper content, sterilized (wipe down with alcohol)
- 3% hydrogen peroxide
- 2 tablespoons citric acid, i.e. fresh lemon juice
- Sterile styrofoam container and utensils for mixing and measuring
- Baking soda
- Clean water

Steps:

1. Cut the size and dimension of fabric needed for the mask
2. To the container, add ½ cup vinegar, 2 teaspoons salt, 2 dimes, and 1 teaspoon hydrogen peroxide, and mix thoroughly for about 30 seconds.
3. Let the solutions sit, covered in plastic wrap, for about one month to allow black copper oxide crystals to grow.
4. Dispose of solution, which contains toxic chemicals, carefully by adding baking soda and dumping in a non-sewage location. Rinse container thoroughly with clean water.
5. Add 2 tablespoons of citric acid and near-boiling (80 - 90 °C) water to the container. Let the solution cool slightly.
6. When the solution is lukewarm, add fabric to the solution and soak overnight.
7. Hang the fabric outside to dry (make sure it does not rain) to get rid of any residual moisture
8. Make cloth into mask

Suggested home-based mechanical method (not tested or approved as anti-viral): This protocol is based off the idea of mechanical abrasion, and the relative hardness of copper vs harder minerals (REF)

Materials:

- Breathable fabric, preferably synthetic or dyed, which contain chemical groups to facilitate copper binding
- Handheld jar with cover
- Large quantity of coins with higher copper content, sterilized (wipe down with alcohol)
- Spare, smooth glass or steel components

Steps:

1. Spread the fabric inside the jar so that it hugs the sides
2. Add the coins and glass/steel components to the jar
3. Shake the jar vigorously or apply mechanical agitation for as long as possible.
4. Remove the fabric and cut fabric into necessary cloth size; make cloth into mask

Level 3: Filti masks

Materials:

- Filti, an N95-grade fabric
- Fix the mask fitting material
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Steps: