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Simulating inhaled transport through bio-inspired pathways in mask filters[1] ANEEK CHAKRABORTY, Jadavpur University, ASHLEY JORGENSEN, South Dakota State University, JISOO YUK, Cornell University, CHUN-I CHUNG, LEONARDO CHAMORRO, University of Illinois at Urbana-Champaign, SUNGHWAN JUNG, Cornell University, SAIKAT BASU, South Dakota State University — Without a COVID-19 vaccine or an antiviral therapeutic, face coverings will become a norm in our lives. Current masks/respirators were not designed for SARS-CoV-2. Their shielding ability from inhaling virus-laden droplets is accompanied by a significant loss in quality-of-life from low breathability. In this scenario, we took cues from the nasal airway shapes in animals with highly enhanced olfactory organs whose tortuous geometries, owing to re-circulating flow patterns therein, can efficiently trap particulates. We consider 4 different bio-inspired designs to serve as air-transmission passages in mask filters and have quantified the droplet capturing efficiency along the airway walls. At tested breathing rates of 15, 30, 55, and 85 L/min, the designs generally capture all droplets bigger than 5 μ and more than 95 percent of the droplets sized at 5 μ. Capturing rates drop to 60-80 percent for 4-μ droplets, 15-30 percent for 3-μ droplets, and beyond that, the capturing efficiency decays exponentially. The simulations use steady-state laminar-viscous models for gentle breathing; RANS-based SST k-ω and LES schemes to track turbulent transport at higher inhalation rates. Finally, we extract the inlet-to-outlet pressure gradients to quantify for breathability.

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