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Improved filtration efficacy and breathability of eco-friendly biofilters against SARS – CoV 2 virus using rotary jet spinning technology

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The global health crisis caused due to SARS – CoV 2 virus (COVID – 19) has increased the use of personal protective equipment and led to the disposal of a tremendous number of masks made of non-biodegradable polymers. The commercial N95 and the surgical masks are usually made of polymers such as polypropylene and polyester, which are not recyclable and do not degrade over time. In addition to the health crisis, COVID -19 indirectly caused an environmental crisis, especially the disposal of N95, surgical, and single-use non-woven masks made with non-biodegradable polymers. Polylactic acid (PLA) is a well-known eco-friendly polymer that is recyclable and biodegradable, capable of replacing polypropylene and other such polymers as non-woven fibers to manufacture N95s and surgical masks. In this work, the non-woven nano- and micro-fibers of PLA were produced by a rotary jet spinning (RJS) technique that has the potential for mass production. The process parameters that aid the formation of nanoporosity within the microfibers were discussed. The microstructure of the fibers was analyzed by scanning electron microscopy (SEM) and a non-invasive X-ray microtomography (XRM) technique was employed to study the three-dimensional (3D) morphology and the porous architecture. Particulate matter (PM) and aerosol filtration efficiency were tested by OSHA standards with a broad range (10–1000 nm) of aerosolized saline droplets. The viral penetration efficiency was tested using the ΦX174 bacteriophage (~25 nm) with an envelope, mimicking the spike protein structure of SARS-CoV-2. Although these fibers have a similar size used in N95 filters, the developed biofilters present superior filtration efficiency (~99%) while retaining better breathability (<4% pressure drop) than N95 respirator filters.

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