DEVELOPMENT OF BIODEGRADABLE AND ANTIVIRAL SURGICAL FACE MASKS FROM POLY(LACTIC ACID) AND POLY(DIMETHYLSILOXANE)-BASED POLYHYDROXYURETHANES

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ABSTRACT

The COVID-19 outbreak urged the use of personal protective equipment (PPE) by society and healthcare workers around the world. [1] Among the different PPE, surgical face masks have been imposed by governments of different countries, including Canada, to be worn in the workplace, schools, and other closed spaces, as COVID-19 is a viral respiratory disease, which gets transmitted through saliva droplets and bioaerosols emitted by breathing, talking, sneezing, and coughing. [2] This restriction has led to an increase in demand of surgical face masks, and it is estimated that the world population is using and throwing away 3.7 billion face masks every day. [3] In fact, most of the commercial surgical face masks are disposable. They are made of non-woven fabrics of synthetic polymers, mainly poly(propylene) and poly(acrylonitrile), by means of different polymer processing methods, such as electrospinning. [3, 4] Because they are disposable, environmental concerns were raised against their excessive consumption since they are seen as a new source of plastic waste that could potentially pollute the soil and water resources. [3, 5] Also, their filtration efficiency gradually decreases, [6] and they become contaminated hosts of different viruses and microorganisms causing a health threat to the person wearing the mask, especially if they are healthcare professionals. [7] As a result, the scientific community has recently recommended the preparation of sustainable and high-performance surgical face masks with multifunctional properties. [3, 8, 9] Hence, the development of biodegradable face masks with antiviral and antimicrobial activities would resolve the environmental and health issues associated with conventional surgical face masks. [3, 9, 10]

In this work, poly(lactic acid) (PLA) is being blended with a poly(dimethylsiloxane)-based polyhydroxyurethane (PDMS-PHU) to prepare biodegradable surgical face masks. PLA is a known biopolymer for its outstanding physical and mechanical properties, but it suffers from poor ductility and impact toughness. Polyhydroxyurethanes (PHUs), on the other hand, constitute a promising class of non-isocyanate polyurethanes whose monomers can be bio-sourced. In fact, PHUs do not contain isocyanates, which are toxic base monomers of conventional polyurethanes, and they are prepared from the polyaddition of dicarbonates with diamines. [11] The PHUs herein are synthesized from a sugar derived dicarbonate and a PDMS-

based diamine. The PDMS soft segments are expected to provide the PLA matrix with the necessary flexibility and toughness to be processed and electrospun, whereas, it is anticipated that the hydroxyl groups dangling from the PHU backbone would bridge between the two polymer phases through hydrogen bonding. [11, 12] Different PLA/PDMS-PHU blend ratios are studied, and their thermal, rheological, mechanical, morphological, and microstructural properties are examined. Owing to the hydrophobic and biocompatibility nature of PDMS, the antimicrobial properties of the developed blends are assessed as well against different kinds of bacteria. Indeed, the hydrophobic character of PDMS allows the formation of anti-biofouling surface that prevents bacterial adhesion. [13]

At a later stage, it will be attempted to melt or solvent electrospin fibers from those blends while incorporating natural agents extracted from aloe vera plants and brown algae; aloe vera extract and laminarin, respectively, which showed antiviral activities against different pathogens. [14, 15] After optimizing the electrospinning process, the resulting non-woven textiles will be tested for their antimicrobial and antiviral properties.

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