World Academy of Science, Engineering and Technology
International Journal of Materials and Textile Engineering
Vol:17, No:02, 2023

Evaluation of the Biological Activity of New Antimicrobial and Biodegradable Textile Materials for Protective Equipment

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Abstract : During health crises, such as COVID-19, using disposable protective equipment (PEs) (masks, gowns, etc.) causes long-term problems, increasing the volume of hazardous waste that must be handled safely and expensively. Therefore, producing textiles for antimicrobial and reusable materials is highly desirable to decrease the use of disposable PEs that should be treated as hazardous waste. In addition, if these items are used regularly in the workplace or for daily activities by the public, they will most likely end up in household waste. Furthermore, they may pose a high risk of contagion to waste collection workers if contaminated. Therefore, to protect the whole population in times of sanitary crisis, it is necessary to equip these materials with tools that make them resilient to the challenges of carrying out daily activities without compromising public health and the environment and without depending on them external technologies and producers. In addition, the materials frequently used for EPs are plastics of petrochemical origin. The subject of the present work is replacing petroplastics with bioplastic since it offers better biodegradability. The chosen polymer is polyhydroxybutyrate (PHB), a family of polyhydroxyalkanoates synthesized by different bacteria. It has similar properties to conventional plastics. However, it is renewable, biocompatible, and has attractive barrier properties compared to other polyesters. These characteristics make it ideal for EP protection applications. The current research topic focuses on the preparation and rapid evaluation of the biological activity of nanotechnology-based antimicrobial agents to treat textile surfaces used for PE. This work will be carried out to provide antibacterial solutions that can be transferred to a workplace application in the fight against short-term biological risks. Three main objectives are proposed during this research topic: 1) the development of suitable methods for the deposition of antibacterial agents on the surface of textiles; 2) the development of a method for measuring the antibacterial activity of the prepared textiles and 3) the study of the biodegradability of the prepared textiles. The studied textile is a non-woven fabric based on a biodegradable polymer manufactured by the electrospinning method. Indeed, nanofibers are increasingly studied due to their unique characteristics, such as high surface-to-volume ratio, improved thermal, mechanical, and electrical properties, and confinement effects. The electrospun film will be surface modified by plasma treatment and then loaded with hybrid antibacterial silver and titanium dioxide nanoparticles by the dip-coating method. This work uses simple methods with emerging technologies to fabricate nanofibers with suitable size and morphology to be used as components for protective equipment. The antibacterial agents generally used are based on silver, zinc, copper, etc. However, to our knowledge, few researchers have used hybrid nanoparticles to ensure antibacterial activity with biodegradable polymers. Also, we will exploit visible light to improve the antibacterial effectiveness of the fabric, which differs from the traditional contact mode of killing bacteria and presents an innovation of active protective equipment. Finally, this work will allow for the innovation of new antibacterial textile materials through a simple and ecological method.

Keywords : protective equipment, antibacterial textile materials, biodegradable polymer, electrospinning, hybrid antibacterial nanoparticles

Conference Title : ICFSN 2023 : International Conference on Fiber Science and Nanofabrics

Conference Location : Jeddah, Saudi Arabia

Conference Dates : February 20-21, 2023