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DISRUPTIVE MATERIAL TECHNOLOGIES TO ADDRESS MICROBIAL HAZARDS FOR SPACE HUMAN EXPLORATION

Abstract

The scenarios and priorities for the public health response to the COVID-19 pandemic have demonstrated the need to extend the knowledge for tools required to microbial control in confined spaces and indoor environments. This is particularly crucial during space missions when the astronauts live in confined spaces for long periods. Indeed, long-term space flight can induce a reduction in immune competence among crew and may cause deleterious changes to the composition of the gastrointestinal, nasal, and respiratory microbiome. Moreover, the spacecraft environment and microgravity condition may also affect the susceptibility of microorganisms to antibiotics, and modify the virulence of airborne pathogens that could contaminate the environment of the International Space Station (ISS) and other flight platforms. In order to best reduce the risks of infection, it is therefore necessary to develop new prevention systems or improve existing ones. For space applications, with a thought to the ISS program or considering the future long-term space flights, where the crew shares confined environments for a while, it is therefore pivotal the development of new functional materials suitable either for self-cleaning surfaces and for antimicrobial textiles. The personal protective equipment (PPEs), for example, are the most useful tools for decreasing the likelihood of airborne transmission in confined spaces and indoor environments. In addition, the development of hard surfaces with self-cleaning properties can play a crucial role in the control of person-to-person transmissible infections, considering confined spaces shared for a long time. In this paper are examined various technologies used to manufacture polymer materials and composites, highlighting the importance of antimicrobial properties and their economic and environmental sustainability. Due to their peculiar characteristics, electrospun nanofibers have attracted wide attention as soft materials useful for numerous applications such as tissue engineering, food packaging and air purification, often being able to combine their properties with some antimicrobial properties through the

specific fillers. On this topic, Fondazione E. Amaldi (FEA) in collaboration with Rete Ferroviaria Italiana (RFI) and Consiglio Nazionale delle Ricerche (CNR) are involved in the development of new textiles with antimicrobial properties that may be used for the fabrication of PPE. Regarding hard materials, the development of self-cleaning surfaces is a hotly debated topic to date. Although optimal results have not yet been obtained, research is very active in this field because functional surfaces with superhydrophobic and superoleophobic properties could have many interesting applications.