Indoor air disinfection in dynamic dark operating conditions

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Abstract

It is well knowledge that working males spend 90 percent of their day (21.7 hours) indoors, whereas married housewives spend 95 percent of their day (22.8 hours) indoors. In this context, one of the strategic goals in the domains of community hygiene and healthcare is indoor air conditioning (climatic, chemical, and antimicrobial). The photocatalytic air recycling techniques are presently receiving the most attention among recent technologies used for indoor air antibacterial cooling. External energy inputs are required to activate all photocatalysts (energetically-dependent materials). The energy costs of long-duration recycling photocatalytic systems become particularly critical in voluminous restricted areas. The prospects of using non-photocatalytic dark-operating active compounds for germicidal conditioning of ambient media have also been considered. These species, which are most commonly found as metal or metal oxide-based nanomaterials (M/MO-NMs), including free nanoparticles (NPs), have been proclaimed to be energetically independent, meaning that they do not require external excitation to function. The most commonly investigated contributing element to the germicidal capacity of the materials under investigation is oxidative stress caused by reactive oxygen species (ROS) generated when M/MO-NMs and NPs surfaces come into contact with humid media. Certain fibrous and tube-like shaped species have a second mechanism that can cause significant mechanical cellular injury. DOGMs (darkoperating germicidal materials) are mostly used in an aqueous media and are frequently used in static situations. The results of the deployment of two new DOGM types for dynamic indoor air antimicrobial conditioning in recycling working mode are discussed in this paper: a MnO2-based interactive ROS generator and a ZnO-based blade-needle-shaped cellular destructor (300 L pilot unit, airborne bacteria, real-time viable particle counter 9510-BD BioTrak, different circulation rates). People in wealthy nations spend more than 85% of their time in confined spaces. In this context, one of the strategic goals in the domains of community hygiene and healthcare is indoor air conditioning (climatic, chemical, and antimicrobial). The photocatalytic air recycling techniques are presently receiving the most attention among recent technologies used for indoor air antibacterial cooling. Photocatalysts have been at the forefront of bacteria inactivation research since Matsunaga et al. first investigated titanium dioxide TiO2 for this purpose. All photocatalysts, on the other hand, are energy-dependent materials that require external energy to activate. The energy costs of recycling photocatalytic long-duration processes become considerable in large restricted environments. Furthermore, photocatalytic reactions at the surface of an active material require time to complete, and the contact time between the disinfecting agent and the air is a key component in air conditioning processes.

The utilisation of non-photocatalytic dark-operating active compounds for the germicidal conditioning of environmental media has also been considered. These species, which are found in the majority of cases as metal or metal oxide-based nanomaterials, as well as free nanoparticles, are proclaimed to be energetically independent, meaning that they do not require external energy to function. The most commonly studied contributing element to the germicidal activity of the materials under investigation is the oxidative stress caused by reactive oxygen species (ROS) generated when metal or metal oxide-based nanomaterials and nanoparticles come into contact with damp conditions. For some fibrous and tube-like shaped species, the second mechanism, which can trigger cell lysis by mechanical destruction of the cell membrane, is accessible. Germicidal materials have mostly been used in aqueous environments and under static working conditions in environmental applications until this day. The substance and the biological contamination might have a long interaction duration under these circumstances. However, findings are dependent on the test technique, and this form of test is unable to assess the effectiveness of abrasive materials by design. Dynamic studies on silver-enhanced composites, for example, have been conducted to simulate life-like situations and brief contact duration. Real-time monitoring of microorganisms in the air has recently become a new method of evaluating the efficacy of air treatment and conditioning systems. The goal of this study was to assess the germicidal potential of two new dark-operating germicidal materials (DOGM), a MnO2-based interactive reactive oxygen species generator (ROS-DOGM) and a ZnO-based desert-rose-shaped cellular destructor (Mecha-DOGM), both of which were designed and synthesised specifically for this purpose. Manganese dioxide was chosen for its capacity to create hydroxyl radicals without the usage of energy, while zinc oxide was chosen for its crystalline structure, which allows for the construction of a wide range of shapes. The active chemicals, MnO2 and ZnO, were produced on the surface of macroscopic alumina beads to avoid any powder escape in the treated air. Chemical attachment of the surface oxide components to the host support was possible because to the synthesis methods utilised. The manufacture of these composite materials, as well as the evaluation of their germicidal characteristics using two separate test methods: the agar diffusion inhibitory test and a dynamic test technique designed to mimic life-like situations, are described in this paper

Extended Abstract

Biography

Alienor Chauvin is a 2nd year PhD student skilled in Chemical Engineering and Applied Microbiology. Graduate chemist engineer (ENSIACET, France), Master degree in Process Engineering and Environment(ENSIACET, France), currently PhD student in Physico-Chemistry of Materials (IMT-Mines Alès, France) Currently, in the framework of the H2020 MSCA-RISE-2015 NANOGUARD2AR project, she is working on germicidal energetically independent dark-operating composite nanomaterials which present an alternative attractive way for the indoor air antimicrobial conditioning. Area of Interest is Interactions between materials and environment.

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