Effects of Ultraviolet-C Germicidal Irradiation on Aircraft Cabin Interior Materials

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Abstract

The outbreak of a novel coronavirus (COVID-19) in December 2019 had resulted in a pandemic bringing many operations across the globe to a halt. In order to reduce the virus transmissions, a wide range of stringent measures were implemented across various industries. The aviation industry had determined to implement additional cleaning and disinfectant procedures along with the existing standard practices to contain the virus spread during air travel. The disinfectant procedures included conventional liquid disinfectants as well as novel measures such as Ultraviolet-C (UV-C) germicidal irradiation, thermal disinfection, disinfection through fogging, etc. However, the frequent and extensive use of the disinfectant products established a need to understand the long-term effects of disinfectant procedures on the aircraft interiors. This study in particular explores the impact of long-term exposure of ultraviolet-c irradiation on various aircraft cabin interiors made of plastic, honeycomb, and composite materials.

The ultraviolet-c wavelength spectrum with germicidal irradiation is defined to be between 200-280 nm. In the current research program, three different UV-C irradiations with peak emissions at 253.4 nm, 222 nm and 280 nm were evaluated. The efficiency of UV-C irradiation to inactivate microbes depends on the dosage and these values were determined based on literature review. According to the International Ultraviolet Association (IUVA), the current ultraviolet-c dose necessary to inactivate the virus on flat and ideal surfaces for emissions at 253.4 nm should at least be 40 mJ/cm^2 [1]. For the 222 nm and 280 nm configurations, the baseline dosage required for over 99% virus inactivation was determined to be 3 mJ/cm^2 and 37.5 mJ/cm^2 respectively [2][3]. With single ultraviolet-c treatment dose as the baseline, cumulative dosages were calculated to represent one year, four year and eight years' worth of ultraviolet-c exposure assuming one treatment per day. The ultraviolet-c light sources used in the study are: Rayonet reactor for 253.4 nm, Ushio Care222 B1 illuminator for 222 nm, and Aquisense 24G UVinaire LED lamp module unit for the 280 nm wavelength configuration.

Six different types of unreinforced thermoplastics, one honeycomb material, and one fiberglass composite material were exposed to long-term ultraviolet-c germicidal irradiation. The test specimens were placed on a test bed underneath the respective UV-C light sources for the exposure duration calculated for each wavelength configuration. The specimens were then evaluated for change in mechanical properties and discoloration when compared to their pristine counterparts. The six plastic materials were evaluated for change in tensile properties following ASTM D638 tensile test standard, honeycomb material was evaluated for change in flexural properties as per ASTM D7249, and the fiberglass laminate was evaluated for change in short beam shear strength properties as per ASTM D2344.

References

1. Advice for the selection and operation of equipment for the UV disinfection of air and surfaces |URL - https://www.iuva.org/Advice-selection/operation-of-equipment-for-the-UV-disinfection-of-air-and
2. Effectiveness of 222-nm Ultraviolet Light on Disinfecting SARS-COV-2 Surface Contamination, Hiroki Kitagawa, Toshihito Nomura, Tanuza Nazmul, Keitaro Omori, Norifumi Shigemoto, Takemasa Sakaguchi, Hiroki Ohge, Sep 4th 2020.
3. Rapid Inactivation of SARS-CoV-2 with Deep-UV LED Irradiation, Hiroko Inagaki, Akatsuki Saito, Hironobu Sugiyama, Tamaki Okabayashi, Shouichi Fujimoto, 2020, Emerging Microbes & Infections, 9:1, 1744-1747, DOI: 10.1080/22221751.2020.1796529.