Deep learning algorithm for hyperspectral analysis of microplastic released from face masks

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Abstract

The critical issue raised by the COVID-19 pandemic is the increased consumption of non-reusable personal protective equipment, such as face masks or gloves. Polypropylene is the primary polymer used for fabricating face masks, which is also highly suspected of UV irradiation. In combination with improper disposition, it makes masks the major source of secondary micro- and nanoplastic. In this study, we adapted the deep learning algorithm and enhanced dark-field microscopy coupled with hyperspectral imaging (EDFM-HSI) to identify microplastic released from differently structured mask layers.
In order to artificially age the spunbond outer layer and meltblown middle layer of the 3-ply polypropylene surgical mask, we have placed samples in the UV exposure chamber with a monochromatic UV-C lamp (254 nm) for the 192 h. The EDFM-HSI was used for the visualization and hyperspectral data (400-1000 nm wavelength range) acquisition of samples before and after UV irradiation. One-dimensional convolutional neural network (1D-CNN) with 8 convolutional layers and 1.8 m of parameters was trained and validated on the dataset composed of ≈700,000 spectra from untreated samples of spunbond and meltblown layers as well as background. After 100 epochs of training, the obtained model was used for the pixel-wise classification of whole hypercubes in the testing dataset. The performance of the 1D-CNN model based on the F-score was 0.84 and 0.62 for untreated and UV-irradiated samples, respectively.

The results revealed strong fragmentation of UV-treated samples to microsized particles caused by photooxidation. The reduced performance of the 1D-CNN model after UV irradiation was also observed. However, the hyperspectral analysis with a deep learning algorithm demonstrated the potential to identify microplastic released from different face mask layers.
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Keywords: deep learning, darkfield microscopy, hyperspectral imaging, face mask, secondary microplastic

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