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Ozone stress monitoring of plants based on OCT biospekcle imaging: 2nd report

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Introduction

In this study, O_3 stress in plants was investigated by using optical coherence tomography. In the experiments, *Allium tuberosum* commonly known as Chinese chive was exposed to 0, 120 and 240ppb ozone concentrations for 3 hours and effect was observed by OCT from both leaf front and back surfaces. In addition to two-dimensional normal structural observation, biospeckele signal was utilized as a functional visualization. The speckle pattern that varies dynamically due to moving particles and organelles within the material is called as biospeckle which is a characteristic feature of a living biological substance and effects the biological activities[2].

Experiments and discussio

The spectral domain-OCT system used in this experiment is a fiber based one with a SLD at central wavelength 836.1nm and axial resolution (depth resolution) was estimated to 6μm. OCT imaging data were collected subsequently before, 1, 2, 3 hours after starting and 1, 2, 3 hours after stopping O_3 exposure. After capturing OCT cross-sectional image of *Allium tuberosum* plant leaf, the relevant standard deviation (SD) biospeckle image was obtained by calculating the standard deviation of the OCT temporal signal (biospeckle signal) obtained at each point in the cross-sectional image along the time axis. In the analysis, a 1000μm lateral region was selected in order to improve the signal to noise ratio. Maximum values of laterally averaged SD depth profiles (Fig. 1) were taken and plotted with the time intervals of *before, 1,2,3 hours after* starting as well as *1,2,3 hours after stopping ozone exposure.*

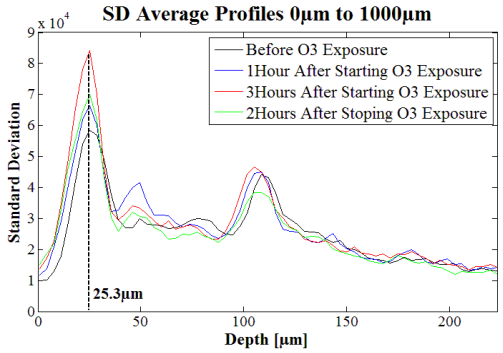

Figure 1

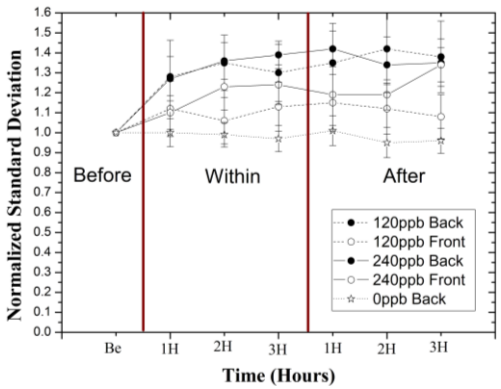

Figure 2

Figure 2 shows the dependence of normalized maximum SD of biospeckle signal on O_3 exposure. In order to normalize, the maximum value of SD average depth profile (Fig. 1) obtained before ozone exposure was taken as unity. As it can be seen from the figure, the fluctuations increase for both back and front surfaces, under exposure of 240ppb as well as 120ppb ozone concentration. It can be seen that normalized standard deviations (NSDs) of back surface were larger than the those of the front surface. The difference of average NSD between front and back surfaces after 240ppb O_3 exposure was 13%. On the other hand, the relevant value for 120ppb O_3 was 26.7%. Therefore the effect of O_3 stress appears more rapidly and significantly on the back side of the leaf in such a short term O_3 exposure. For such a difference in exposing O_3 on the front and back sides, the stomata may play a significant role. These results show OCT biospekcle imaging method is capable of monitoring O_3 stress on plats within few hours of exposure meanwhile conventional techniques for studying these changes in plants require destruction and subsequent analysis as well as long waiting periods.

References

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2. Fujimoto J .*et. al*, Optical Coherence Tomography: Technology and Applications, 2008