

和周波発生分光法によるプラズマ照射された生体分子の測定

Measurement of plasma-irradiated biomolecule using sum frequency generation spectroscopy

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1. Background

Studies on biological application using atmospheric pressure plasma (APP) have attracted attention over the years. It is important to analyze the structure change of the cell surface treated by APP. In this study, we focused on Sum Frequency Generation (SFG) spectroscopy to observe the molecular structure of cell surface. SFG is a spectroscopic technique based on the second-order nonlinear effect. When a sample is irradiated by infrared light (ω_1) and visible light (ω_2) simultaneously, SFG light ($\omega_1 + \omega_2$) is generated at interface of the sample. In addition, the SFG signal from the bio-molecule is obtained when the frequencies of molecular vibration and the infrared light are harmonized. In this study, a glucose film which is a model sample of biomolecule was used as a sample. SFG spectroscopy measurement of the glucose film was carried out after the APP treatment.

2. Experimental

Fig.1 shows the optical system of SFG spectroscopy. Wavelength-scanned infrared laser light (ω_1 : 2500-10000 nm, energy: 0.1 mJ, pulse width: 20 ps) and visible laser light (ω_2 : 532 nm, energy: 5 mJ, pulse width: 25 ps) were simultaneously irradiated the glucose coated on quartz substrate. SFG signal was detected with a photomultiplier via monochromator.

3. Results

Fig.2 shows SFG spectra of glucose film with various plasma irradiation time. The SFG signals of C-H stretching vibration at the 6th C atom of carbon chain at 2868 cm^{-1} , asymmetric C-H stretching vibration at the 6th C atom at 2887 cm^{-1} was observed.^[1] SFG intensities at

2868 cm^{-1} and at 2887 cm^{-1} decreased with the plasma irradiation time. These results indicate that a primary alcohol was changed to a carboxylic acid by reactive oxygen species (ROS) produced from the plasma. The SFG signals of C=O stretching vibration attributed to carboxylic acid was observed at 1732 cm^{-1} . The SFG intensity of at 1732 cm^{-1} increased with increasing plasma irradiation time. In general, alcohol is oxidized to aldehyde, and then C-H bond is changed into C=O bond. The oxidation reaction initiated by the APP treatment at the air / glucose interface was observed by the SFG spectroscopy.

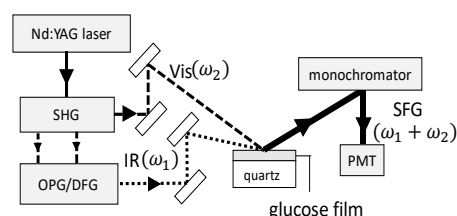


Fig.1 Optical system of SFG spectroscopy.

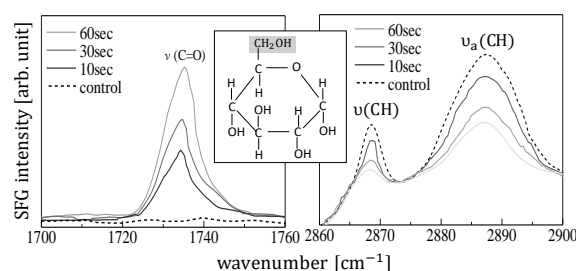


Fig.2 SFG spectra of glucose film with various plasma irradiation time.

Reference

- [1] H. Hoang, L. Hongyan, M. Yoshihiro, M. Goro, F. Naoko; Spectrochim. Acta A, 138 (2014) 834 – 839.