

Masafumi Ito <sup>1</sup>

<sup>1</sup>Meijo University, Japan

Recently, the applications of non-equilibrium atmospheric-pressure plasmas (NEAPPs) have been intensively studied in agricultural fields. [1] NEAPPs can inactivate microorganisms such as *Escherichia coli* and spores of fungi. In our previous works, we found that the ground-state atomic oxygen O(<sup>3</sup>P<sub>j</sub>) generated by a commercially available atmospheric-pressure radical source (Fuji Machine MFG.CO., LTD. FPA-10) can be a key species in activation of microorganisms with a *Penicillium digitatum* spores. Moreover, we found quantitatively that ground-state atomic oxygen O(<sup>3</sup>P<sub>j</sub>) was the dominant factor responsible for inactivating spores of *P. digitatum* and *Aspergillus flavus* and *niger*. [2-4]

In addition, we have investigated the effect of atomic oxygen radical treatment on the fungal-spore activation by monitoring amylase production of *Aspergillus oryzae* (*A. oryzae*), which is very beneficial microorganism and employed for decomposing starch to glucose in the process to produce Japanese sake. We irradiated the oxygen radicals to *A. oryzae* spores in the similar manner to the inactivation processes described above. As a result, amylase activity secreted from the irradiated *A. oryzae* spores was 1.9-fold higher than that of untreated ones.

Moreover, we tested whether oxygen-radical pretreatment enhances cellulolytic activity. Cellulose is the most abundant poly-saccharide found in plant biomass, consists of a  $\beta$ -1,4-linked linear chain of glucose units. The efficiency of cellulolytic enzymes is important in industrial biorefinery processes, including biofuel production. The production of reducing sugar from oxygen-radical-pretreated carboxymethyl cellulose (CMC) by commercially available cellobiohydrolases I and II was 1.7- and 1.6-fold higher, respectively, than those from non-pretreated and oxygen-gas-pretreated CMC. Moreover, the amount of reducing sugar from oxygen-radical-pretreated wheat straw was 1.8-fold larger than those from non-pretreated wheat straw. [5]

These results indicate that the control method using neutral radical irradiation has a great potential to be applied for an activity-promotion process of microorganisms and enzyme degradation of biomass.

## References

[1] M. Ito, et al., *Plasma Processes and Polymers*, 14, e1700073, (2017).

---

[2] S. Iseki, et al., *Appl. Phys. Express*, 4, 116201(2011).

[3] H. Hashizume, et al., *Jpn. J. Appl. Phys.* 52, 056202(2013).

[4] H. Hashizume, et al., *Appl. Phys. Lett.*, 103, 153708(2013).

[5] K. Sakai et al., *Biotechnol. Biofuels*, 10, 290(2017).

This work was partly supported by MEXT-Supported Program for the Strategic Research Foundation at Private Universities (S1511021) and a project for Promoting Research Center in Meijo University.