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Activation and inactivation of microorganisms using radical source for plasma agriculture

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The applications in biotechnological and medical fields using nonequilbrium atmospheric pressure-plasmas (NEAPPs) have been intensively studied. The inactivation of microorganisms using NEAPPs has been attracted much attention due to the low temperature processing and high speed treatment.

We inactivated Penicillium digitatum spores using an atmospheric pressure plasma in gas phase and focused on the effects of neutral oxygen radicals on the inactivation using an atmospheric-pressure oxygen radical source, which selectively supplies neutral oxygen radical species without charged species and UV radiation. We measured the densities of the neutral oxygen radicals, such as ground-state atomic oxygen (O(3Pj)) and singlet oxygen molecule (O2(1Δg)), using a vacuum ultraviolet spectroscopy system, and inactivated P. digitatum spores quantitatively. The inactivation efficiencies corresponded to the O(3Pj) density. Therefore, we found quantitatively that O(3Pj) was the dominant factor responsible for inactivating P. digitatum spores.

However, many kinds of microorganisms are living in liquid phase and so it is important to investigate the inactivation mechanism, especially the effect of the neutral oxygen radicals produced in the gas phase on the inactivation in liquid. In addition, the kind of solution is important factor to inactivate the microorganisms in liquid.

Moreover, we found a growth promotion effect of budding yeast cells in PBS treated with oxygen radicals using an atmospheric-pressure oxygen radical source. However, the main factors for the promotion and the inactivation of microorganisms in PBS solutions treated with oxygen radicals have not been elucidated.

In this study, we have treated budding yeasts and Escherichia coli (E. coli) using neutral oxygen radical source. The activation and inactivation effects of neutral oxygen radicals on microorganisms were investigated using a cell count and a colony count method, respectively. Based on the measurements of free residual chloride and hydrogen peroxide concentrations in the solutions treated with oxygen radicals, we have investigated their effects on the activation and the inactivation.

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