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Plasma-functionalized solution and its applications

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Active attempts to apply atmospheric-pressure plasma science and technology to various areas, such as microelectronics, environmental and biomedical applications, and more recent food and agriculture, have produced impressive results and shown the potential for using plasma in various industries. Owing to the great applicability and reactivity, plasma-functionalized solution [such as plasma-treated water (PTW)], which contains a considerable amount of reactive species, have become increasingly of significance interest. As the application field of PTW has extending, the in-depth understanding of PTW properties has been acquired for specific purposes. For instance, the multiple oxidants formed in PTW have the potential for high antibacterial activity against various bacterial infections. In this presentation, an introductory overview of the research on PTW will be provided. And as a good example, here we representatively report the antibiotic potency of PTW. To illustrate the applicability of PTW for disinfecting biological substances, an Escherichia coli biofilm was used. We sought to identify the chemical species in PTW and investigate their separate effects on biofilm removal. Dielectric barrier discharge in ambient air was used to prepare the PTW and treat the biofilm directly. Hydrogen peroxide, ozone, and nitrites were identified as the long-lived reactive species in the PTW, whereas hydroxyl radicals and superoxide anions were identified as the short-lived reactive species in the PTW; all these species showed an ability to disinfect in biofilm removal. Our findings indicate that hydroxyl radical, which is most important and interesting chemical in various fields from environment to biomedicine, play a crucial role in PTW despite its low concentration. In this regard, the origin of hydroxyl radical was investigated, particularly, we focused on the photolysis of hydrogen peroxide and nitrous acid (or nitrite ion) as a major source of effective hydroxyl radical.

References

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