Deactivation of Oral Bacteria Using an Atmospheric Plasma Brush

B. Yang[1,2], J.R. Chen[2], Y.J. Kim[1], A. Ritts[1], Q.S. Yu[1,*], H. Li[1], L. Hong[3], Y. Wang[3], M. Chen[4]
[1] Center for Surface Science and Plasma Technology, Department of Mechanical and Aerospace Engineering, University of Missouri, Columbia, MO 65211, USA
[2] School of Energy and Power Engineering, Xi'an Jiao Tong University, Xi'an 710049, P.R. China
[3] School of Dentistry, University of Missouri–Kansas City, 650 E. 25th Street, Kansas City, MO 64108, USA
[4] Nanova Inc., Columbia, MO 65203

Statement of Purpose: As a biofilm on tooth surface, dental plaque consists of complex communities (usually colorless) of oral bacteria with hundreds of species present.[1,2] These biofilms build up on the teeth surfaces, and if not removed regularly, can lead to one of the most prevalent diseases of mankind and dental caries, which is the localized destruction of tooth tissues by bacterial fermentation of dietary carbohydrates.[3] In this study, oral bacterial deactivation effects of a low temperature atmospheric argon plasma brush were studied in terms of plasma conditions, plasma exposure time, and bacterial supporting media.

Methods: An atmospheric cold plasma brush (ACPB), a non-thermal gas plasma source, was utilized to disinfect oral bacteria seeded in filter papers, glass slides, and PTFE films. Two kinds of dental bacteria, *Streptococcus mutans (S. mutans)* and *Lactobacillus acidophilus (L. acidophilus) with an initial bacterial population density between 1.0 x 10^8 and 5.0 x 10^8 cfu/ml* were seeded on various media and their survivability with plasma exposure was examined. Prior to being used for the plasma treatment, the bacteria were transferred into 10ml TSB and allowed to grow for 24 hrs until the bacterial population density was measured between 1.0×10^8cfu•ml^{-1} to 5.0×10^8cfu•ml^{-1}.

Results: Our experimental results indicated that the argon atmospheric plasma brush was very effective in deactivating these two bacteria. Figure 1 shows the *S. mutans'* survival rate as a function of plasma treatment time. The plasma exposure time for a 99.9999% cell reduction was less than 15 seconds for *S. mutans* and within 5 minutes for *L. acidophilus*. It was found that the plasma deactivation efficiency was also dependent on the bacterial supporting media. Scanning electron microscopy (SEM) was used to examine the morphological changes of the bacteria. With plasma exposure, significant damages to bacterial cell structures were observed with both species of bacteria. Leakage of intracellular protein and DNA after plasma exposure was also observed through monitoring the absorbance peaks at wavelength of 280nm and 260nm, respectively.

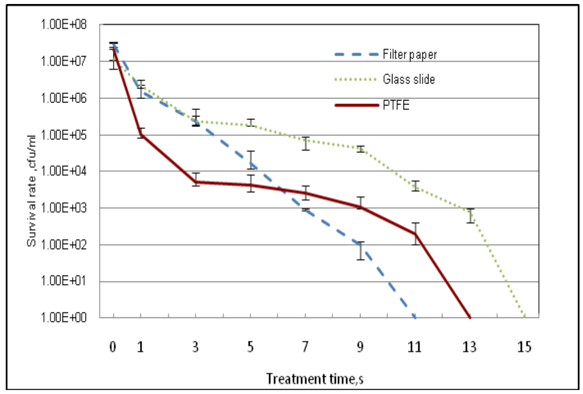

Figure 1. Plasma sterilization effect of *S. mutans* on different mediums. Plasma conditions were 2000 sccm Ar flow rate and 10 W DC Power input.

Conclusions: Our experimental results showed that atmospheric plasma treatment is very effective in killing or sterilizing oral bateria. A short plasma treatment of 13 s could achieve a 99.9999% cell reduction for *S. mutans*. Based on SEM examination, such a plasma brush could induce significant structural damage on oral bacteria, and as a result leakage of both cellular proteins and DNAs. The findings from this study indicated that low temperature atmospheric plasmas could be a promising technique in various dental clinical applications such as bacterial disinfection and caries early prevention.

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