Managing cytotoxic activity and etching effect of plasma for biomedical applications

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Discharge gas generated from plasmas has been widely used and investigated in many industrial and medical applications for sterilization and decontamination [1]. It is believed that reactive species and UV photon generated in the plasma all have a direct impact on the microorganisms, especially on their outmost membranes and on the cell walls [2].

We found that discharge gases with distinct chemical properties had strong activity to pre-formed biofilms from various bacterial strains on biomedical devices [3]. Further studies revealed that two different mechanisms were involved in discharge gas mediated biofilm inactivation. The first involved the diffusion of discharge gas in biofilms which causes the erosion of bacteria cells and resulted in severe damages to the cell membrane. Bacterial damage at the cellular level could happen even at low discharge power and after short time exposure. The second mechanism involved the etching effect associated with discharge gas generated at high discharge powers or after long time exposure. Discharge gases caused a chemical break down in biofilm extracellular polymeric matrix (EPS) and released bacteria and biofilms from the substrate surface. Biofilms were completely removed after long time exposure and the damage becoming more severe. We also found that different reactive species in plasma were responsible for etching and antibacterial activities of plasma. By controlling plasma device and plasma generation conditions, the etching and cytotoxic activity of plasma could be manipulated and tuned to meet the needs of various biomedical applications. Related studies also represent opportunities to promote the basic plasma research and will enrich our knowledge on plasma chemistry and physics.

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