Public Abstract
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Title:Prevention of Biofilm Formation on Food Contact Surfaces by Nanoscale Plasma Coating

Microbial biofilm formation can lead to a series of important safety problems in food industry because, once formed, the microbial cells are much harder to remove compared to plankton cells and can lead to circulating contamination. Low temperature plasma coating technology is a novel and effective method to prevent biofilm formation. However, previously it was only applied on medical devices.
In this study, the anti-biofilm activity of trimethylsilane (TMS) coating and its adapted recipe TMS+O2 (1:4) on common food contact surfaces: stainless steel (SS) and high-density polyethylene (HDPE) against biofilms formed by common foodborne pathogens. The factors which will affect the anti-biofilm efficacy of this TMS coating was also studied and combined to form a basic theory.
SS or HDPE wafers (1 cm × 1 cm) were coated with TMS or TMS+O2 (1:4) plasma to an approximate thickness of 30 nm using direct current power supply. The surface contact angle to water was tested, and then Escherichia coli O157:H7, non-O157 E.coli, Salmonella, Staphylococcus aureus, and Listeria monocytogenes each was allowed to form biofilms on the wafer surfaces for 48h. The biofilms cells were then be removed by rinsing and ultrasonicating each wafer four times for 30s each time and the pour-plate method was conducted to determine bacterial counts. In addition, the efficacy of TMS-coated wafers in combination with a sanitizer was also tested by dipping the wafers in a Quat solution for 15s and rinsing before sonicating and plating. Besides to that, scanning microscope, Live/Dead laser confocal scanning and gene expression were applied to help study the anti-biofilm mechanism of TMS coating.
Results showed that TMS coating on SS succeed in reducing the cell count of S. aureus cocktail biofilm by around 2 log CFU/wafer (99% reduction) and L. monocytogenes by 1.5 log CFU/wafer. TMS+O2 coating on SS also achieved a 2 log CFU/wafer reduction in S. aureus cocktail biofilm, and a 2 log CFU/wafer reduction in L. monocytogenes cocktail biofilm. On HDPE surfaces, TMS+O2 decreased the cell count by around 1 log CFU/wafer in E. coli O157:H7 cocktail. For different single strains, their efficacy fluctuated and sometimes the total count even increased slightly. However, most of the time, these coatings worked well or at least did not increase the cell count in our study. Factors like bacterial strain (E. coli O157:H7, S. aureus or L. monocytogenes), coating surface (SS or HDPE), coating composition (TMS or TMS+O2), as well as the medium (Tryptic Soy Broth (TSB) or Brain Heart Infusion (BHI)) can all affect the anti-biofilm efficacy of this TMS coating. The mechanism was thought to be related to surface energy and surface contact angle change which can help reduce the initial attachment of bacterial. No change of relative gene expression level was detected which confirmed the theory that this method would not lead to resistant strains. Moreover, when combined with sanitizers, TMS coating shows greater promise to remove and prevent biofilm from forming on stainless steel surfaces. The result showed that TMS plasma coating is a promising method to solve the biofilm issue in food manufacturing lines. However, the theory of anti-biofilm TMS coating was still on basic level and more factors needs to be studied in order to form a well fitted model which can be applied in food industry in the future.