

SURFACE MODIFICATION OF PVC ENDOTRACHEAL TUBE SURFACES TO REDUCE PSEUDOMONAS AERUGINOSA ADHESION: PLASMA PROCESSING AND CHEMICAL METHODS

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INTRODUCTION: *Pseudomonas aeruginosa* is one of the most prevalent bacterial strains in a clinical environment, responsible for 30% of pneumonia cases occurring in intubated and mechanically ventilated patients [1]. Colonization of the intubation device leads to death for over 40% of these cases, despite aggressive antibiotic therapy. This paper presents the development of a strategy to reduce bacterial adhesion based on the surface modification of the polymer commonly used in endotracheal devices, medical grade poly(vinyl chloride) (PVC). The surface properties of biomaterials, such as chemistry, wettability, and morphology play an important role in their interaction with the surrounding environment and the success of their application. Several different surface modification strategies are at a scientist's disposition to alter the physicochemical properties of substrates and make them less attractive to proteins and bacteria. Various methods are evaluated in the scope of this paper. First, a oxygen (O₂) plasma treatment was used to alter the hydrophilicity of native PVC and form an anti-adhesive surface. Secondly, non-fouling surfaces were created through the physisorption of poly(ethylene oxide)-containing (PEO) co-polymers, Pluronic[®], to a fluoropolymer film deposited on native PVC. Thirdly, silver-containing/PEO-like coatings were plasma-deposited in the effort to combine the non-fouling properties of PEO [2] and the well-known bacterial-toxic effects of silver [3]. Fourth, O₂ plasma treatments, followed by a wet chemical treatment in sodium hydroxide and silver nitrate solutions were used to incorporate monovalent silver as a germicidal agent.

METHODS: XPS analysis was used to investigate the chemical nature of the modifications. Surface wettability was determined by contact angle measurements of water sessile drops. Protein adhesion to the various surfaces was studied by incubating the samples in albumin and fibrinogen. Initial bacterial adhesion studies were completed using four different strains of *P. aeruginosa*.

DISCUSSION & CONCLUSIONS: O₂-plasma treatments provided a 70% reduction in bacterial adhesion as compared to native PVC [4]. The O₂-plasma-treated surfaces were prone to ageing effects and are not ideal for an anti-bacterial modification without further steps. The creation of a non-fouling surface by deposition of PEO-like coatings and the physisorption of PEO-containing copolymers, Pluronic[®], was not sufficient to produce an effect on *P. aeruginosa* adhesion. Although the Pluronic[®] F127 and PEO-like surfaces were demonstrated to be non-fouling, they did not prevent bacterial adhesion. The PE-CVD deposition of Ag/PEO-like coatings and NaOH/AgNO₃ wet treatments were the only methods tested that completely prevented bacterial adhesion, due to the bacterial toxic effects of silver. Furthermore, the efficacy of the NaOH/AgNO₃ treatment to reduce biofilm formation over a 72h period was demonstrated as a 7-logarithmic drop in biofilm population at 24h and an 8-logarithmic reduction at 72h, compared to native PVC. It can be concluded that surface modifications that incorporate silver are the most promising of the methods explored in this paper, and do indeed create an anti-*P. aeruginosa* surface. Although a modification may create a non-fouling surface, this property is not sufficient to prevent bacterial adhesion, and a germicidal agent is necessary prevent colonization.

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ACKNOWLEDGEMENTS: The authors would like to thank Nicolas Xanthopoulos for his assistance. We greatly acknowledge the financial support of the Common Program on Biomedical Engineering and Research, Universities of Lausanne and Geneva and EPFL, (1999-2002).