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Title : SURFACE PROPERTIES AND ANTIMICROBIAL PERFORMANCE OF COPPER COATINGS ELECTRODEPOSITED ON 304 STAINLESS STEEL

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Bacterial contamination resulted from frequently-touched surface materials is responsible in the acquisition of infection especially in hospital. The utilization of copper as antimicrobial touch surfaces offers a solution that can serve as an additional line of defense against pathogens. Copper is the first and currently the only one surface metal that has received registration from Environmental Protection Agency (EPA) as antimicrobial material which is capable to inhibit biofilms, retains the antimicrobial activity under typical indoor conditions. In this study, electrodeposition technique was used to coat copper on 304 stainless steel using 0.01 M Cu^{2+} solutions containing either uncomplexed CuSO_4 or complexed Cu-EDTA based systems. Effects of applied potential (based on CV analysis) and deposition time were investigated to study the formation, nucleation and growth of copper on the 304 stainless steel. Copper coatings Cu/SS(-0.25 V, CuSO_4 pH 1, 900 s) and Cu/SS(-1.1 V, Cu-EDTA pH 8, 900 s) prepared at low overpotential from both electrolyte solutions possess good physicochemical and surface properties. In addition, they also have high contact angle, high surface roughness and well-adhered to the substrate. Both copper coatings showed excellent antimicrobial activity towards *E. coli* (100 % reduction within 5min of exposure) and *S. aureus* (100 % reduction within 10 min

of exposure), compared to solid copper (100 % of reduction for both bacteria required within 10 min of exposure) whereas stainless steel surface showed no antibacterial activity even after 30 min of exposure. A significant observation is on the reduction of *S. aureus* after 5 min of exposure with Cu/SS(-1.1 V, Cu-EDTA pH 8, 900 s) showed outstanding antibacterial activity compared to Cu/SS(-0.25 V, CuSO_4 pH 1, 900 s) and solid copper. Even though solid copper has higher dissolution rate (0.1292 mm/yr) than the copper coatings (i.e.: Cu/SS(-0.25 V, CuSO_4 pH 1, 900 s) = 0.0531 mm/yr and Cu/SS(-1.1 V, Cu-EDTA pH 8, 900 s) = 0.08048 mm/yr) but both copper coatings have faster killing rate of bacteria than solid copper. This indicates that the killing rate does not only depend on dissolution rate but also surface properties. Cu/SS(-1.1 V, Cu-EDTA pH 8, 900 s) sample with high surface roughness, hydrophobic, high compositions of copper with uniform distribution of nano-sized grains structure resulted in better and more efficient contact killing of bacteria by allowing copper structure to interact closely with bacterial membranes.