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Non-thermal plasma assisted engineering of antibacterial nano-coatings on medical textiles

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Atmospheric pressure DC jet operating in N_2 at current density of 6 mA/cm^2 and voltage of 15 kV is used as a source of non-thermal plasma for engineering of antibacterial nano-composites on surface of polymeric meshes. Nanoparticles of Ag, Cu and ZnO are incorporated in between two layers of organosilicon film in "sandwich-like structure" where top layer of variable 5 - 50 nm thickness is used for precise control of metal ions release. Deposition is carried out on non-woven polyethylene terephthalate. The deposition process and surface chemistry of the coatings are studied by emission spectroscopy, and surface analysis techniques: XPS, AFM and SEM. The use of atmospheric pressure jet provides possibility for plasma to penetrate inside of the treated non-woven textiles with uniform deposition of the coatings on both sides of substrate. It is revealed that thickness of top (barrier) layer plays a key role in release of antibacterial agent and no antibacterial activity is observed if barrier thickness exceeds 50 nm. Antibacterial activity of novel class of biomedical materials is tested for variation of immobilized nano-particles concentration in double layer coatings. Tests with E. coli and S. aureus show up to 99.7% bacterial reduction at Ag or Cu nanoparticles content of 2.1 at.% and complete reduction at concentration above 7 at.%. Antibacterial activity of ZnO coatings is found considerable lower which agrees with difference in morphology of deposited films. The results clearly indicate that plasma of atmospheric pressure can be used as effective tool for immobilization of nano-particles in composite coatings. Control of antibacterial activity can be achieved through variation of deposition parameters and the approach might present a new route to preparation of effective antibacterial materials.
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