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Atmospheric pressure non-equilibrium plasma jet for acrylic acid plasma-polymerization and co-deposition of antibacterial nanocomposite coatings

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Atmospheric pressure non-equilibrium plasmas, or cold atmospheric plasmas (CAPs) due to their low temperature, are able to support innovative processes for material modification. While the use of low pressure plasma is well assessed, CAPs potentialities are still largely unexplored notwithstanding their advantages of cost and ease of use. In this contribution, two different processes performed by means of a non-equilibrium atmospheric pressure plasma jet are presented: (i) Acrylic acid (AA) plasma polymerization for deposition of polyacrylic acid (pPAA) coatings and (ii) a single-step plasma process for synthesis and co-deposition of nanocomposite coatings containing silver nanoparticles (AgNPs) embedded in a pPAA matrix. Regarding the AA plasma polymerization, the process was carried out onto organic and inorganic substrates. The results underlined that the proposed method enabled the deposition of pPAA coatings with a high amount of –COOH groups, generally higher than 22%, while the thickness and the morphological characteristics of the obtained coatings turned out to be tuneable by varying the operating conditions. Concerning the deposition of AgNPs/pPAA coatings onto polyethylene (PE) substrates, the chemical analysis highlighted a high retention of carboxyl groups (21%) and the presence in the coating of superficially oxidized AgNPs, also assessed by SEM top views. Similarly to the pPAA coatings, the thickness of the coatings was affected by the deposition time. Finally, the antibacterial efficacy of the AgNPs/pPAA coatings was demonstrated. In fact, while no growth inhibition area could be observed around the uncoated PE and pPAA coated PE samples, a clear zone with no bacterial growth was detected around the AgNPs/pPAA coated PE samples due to the release of silver ions, which, diffusing into the agar layer, prevent the growth of microbial colonies.

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