Surface modification of nanoporous alumina by plasma polymerization for biomedical applications

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The development of antibacterial surfaces is critical for advancing medical applications, where bacterial colonization and biofilm formation remain major challenges for implantable devices and diagnostic tools [1]. In this study, we report the surface modification of nanoporous anodic alumina (NAA) via plasma polymerization of 2-methyl-2-oxazoline to fabricate biofunctional coatings with antifouling and bacteriostatic properties.

NAA was synthesized using a two-step anodization process [2], followed by controlled pore widening to achieve pore diameters ranging from 30 to 75 nm, allowing fine-tuning of the surface topography [3,4]. This hierarchical nanostructuring not only enhances surface area but also plays a role in modulating cell and protein interactions [5].

Plasma polymerization was performed using radio-frequency (RF) equipment to deposit thin, conformal polymer layers of poly(2-methyl-2-oxazoline) (PMOXA), a material recognized for its biocompatibility and low protein adsorption [6,7]. Figure 1 presents FESEM images of nanoporous anodic alumina after 20 minutes of pore widening, followed by plasma polymerization for (a) 3 minutes, (b) 5 minutes, and (c) 10 minutes, respectively. The resulting surfaces were characterized by field emission scanning electron microscopy (FESEM), Fourier-transform infrared spectroscopy (FTIR), X-ray photoelectron spectroscopy (XPS), contact angle goniometry, and profilometry. The coatings showed increased hydrophilicity and reduced pore diameter, suggesting partial infiltration of the polymer into the nanopores.

Spectroscopic analysis confirmed the presence of oxazoline functional groups, which are known to impart protein-repellent and bacteriostatic effects [6]. This surface engineering strategy combines the structural versatility and tunability of anodic alumina [2-4] with the chemical functionality of plasma-deposited oxazoline coatings [6,7], enabling the development of next-generation antibacterial and antifouling biomaterials for medical applications [1].

References

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Figures

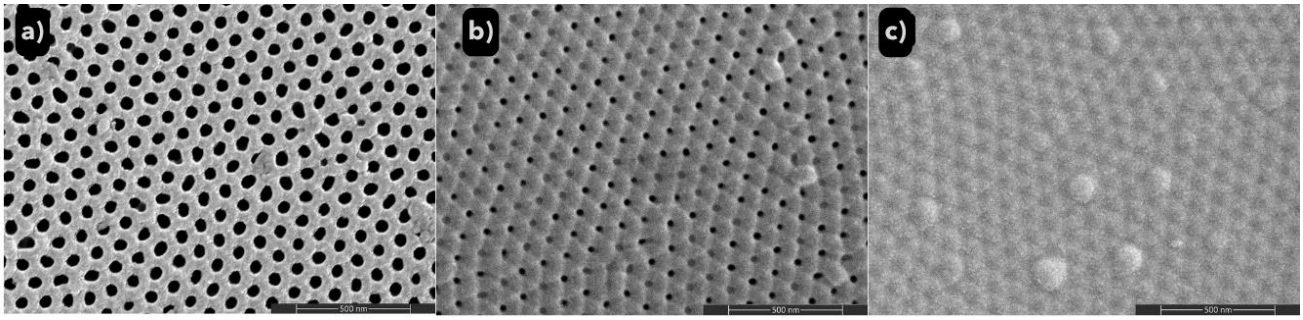

Figure 1: FESEM photographies of pores after 20 minutes of pore widening reaction and a) 3 minutes of plasma polymerization, b) 5 minutes of plasma polymerization and c) 10 minutes of plasma polymerization.