Enhanced Antibacterial Efficacy of PMMA Nanostructures Fabricated via Electron Beam Lithography: A Study on Nanograting and Nanopillar Arrays

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Nanostructured antibacterial surfaces are gaining the scientific community's attention due to their ability to mechanically disrupt bacteria. In this study, an effective fabrication method, based on Electron Beam Lithography, of PMMA nanostructures i.e. nanograting and nanopillar arrays with pitches of 160 to 200 nm is presented. Atomic Force Microscopy (AFM) was used to characterize the structures. Successively, *E. coli* was incubated on these surfaces and a significant reduction in bacterial adhesion, especially on nanopillars, was observed. Bacteria exhibited shape changes and damage, indicating cellular disruption. AFM analysis confirmed reduced major axis length, decreased surface area, and increased roughness, likely from membrane rupture. Nanomechanical studies revealed decreased Young's Modulus and increased Adhesion Forces, particularly in lower-pitch nanogratings and higher-pitch nanopillars. These findings highlight the potential of nanostructured surfaces as advanced antibacterial materials.