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Versatile poly(ethylene) nano-pattern meets nonthermal plasma for enhanced binding of proteins

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Spatially controlled protein immobilization plays a key role in the fabrication of functional protein microarrays, biosensors, and continuous flow reactor systems. Nonthermal plasma surface modification avoids the use of hazardous chemicals and represents a straightforward strategy for grafting polymeric surfaces with proteins.
As a model microarray pattern, we selected recently developed two-dimensional nano-structure of poly(ethylene) (PE) islands on silicon produced by vapor phase deposition. The islands consist of uncross-linked linear $(-CH_2-)_{100}$ oligomers and are attainable in the compact, flat-top terrace shape with constant thickness of 7-8 nm and different lateral size. After the island deposition, they were modified with capacitively coupled RF plasma under 3 Pa of argon. The parameters of the treatment were optimized to avoid any change in the topography of the islands. However at molecular scale, the plasma treatment resulted in breaking of hydrocarbon chains and in generating reactive radicals which can be used subsequently for binding biomolecules specifically on the surface of the nano-islands. Thus-activated surfaces were immersed into the water solution of tropoelastin immediately after the plasma treatment. The attachment of the protein was examined by measuring the XPS N 1s signal before and after rigorous SDS washing to determine the proportion of the protein immobilized covalently. The level of nitrogen on the surface after SDS washing was in direct relation to island coverage, which proves the spot-selective role of the PE nano-structures. Using the AFM technique, we visualized the appearance of anchored proteins on top of the nano-islands.
Taken together, these findings suggest plasma surface engineering of PE nano-islands to be effectivein promoting one-step covalent biomolecule attachment.
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protein immobilization