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Hydrogel coating for biomedical devices covalently attached by means of plasma immersion ion implantation

Hydrogel materials are attractive for a wide range of applications such as tissue engineering, wound healing, controlled drug release, contact lenses, water treatment, biosensors, regenerative medicine as well as in cosmetics. Hydrogels are an ideal medium for promoting optimum biological integration. They provide a suitable environment for attachment and cell growth with good transportation of oxygen and nutrients as well as metabolic substances and cellular waste. They are hydrophilic and mimic the native extracellular matrix.
Hydrogels are soft so they cannot be used directly for applications where mechanical integrity is required, such as in bone implants. However, they could be attached to solid substrates that provide mechanical strength and desired shape.
In this research, stable solid-hydrogel hybrid structures are developed through plasma immersion ion implantation (PIII) of PTFE (Teflon) and polystyrene. Acrylamide monomer was polymerized on the PIII activated surfaces and formed covalent bonds with surface-embedded radicals without any external crosslinking agents or initiators. The amount of hydrogel formed on the substrate increased with the incubation time, monomer solution temperature and concentration.
The stability test results indicated that 95% of the hydrogel coating was retained on the surface even after 4-month incubation in PBS solution. Adhesive T-peel tests were performed, demonstrating an adhesion strength of hydrogel on the PIII-treated PTFE interface of 300-340 N/m. The surface chemistry of untreated, PIII treated, and hydrogel-attached PTFE samples were investigated using X-ray photoelectron spectroscopy (XPS) and attenuated total reflection (ATR)-Fourier transform infrared spectrometry (FTIR). The surface chemistry analyses confirmed the formation of acrylamide hydrogel on the surface. The wettability of the samples was evaluated using water and diiodomethane contact angle measurements, confirming the hydrophilicity of the hydrogel attached surfaces. The water and diiodomethane contact angles were 126.190 and 106.60, respectively for PIII-treated PTFE. With attached hydrogel, the contact angles varied as a function of hydrogel coating thickness, in the range 96.90-52.20 for water and in the range 107.50 -16.780 for diiodomethane. The significantly lower contact angle measured for the hydrogel coatings also confirmed the formation of hydrogel on the solid substrates.
Our results show that PIII-treated polymers provide excellent solid platforms for the creation of robust solid-hydrogel hybrid structures.

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