

Synthesis of polymeric hydrogel coatings with an atmospheric pressure plasma jet for biomedical applications

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Introduction:

Cold atmospheric plasma polymerization (CAPP) has gained a lot of attention in the last decade due to its ability to generate new kinds of innovative coating materials, especially for biomedical applications^{1, 2}. Here we demonstrate the generation of stimuli responsive hydrogels with monomer combinations of (hydroxyethyl) methacrylate-co-2-(diethylamino)ethyl methacrylate (HEMA-co-DEAEMA) by CAPP. We provide insights into recent developments of a single-step process to generate plasma-polymerized hydrogels, to enhance and improve sensing properties, mechanical strength and deleterious effects.

Methods:

The plasma-polymerized hydrogels were generated by a non-thermal atmospheric pressure plasma jet³, operating at a frequency of 27.12 MHz and power inputs between 5-10 W using 1 slm Argon as process gas. For the coatings a 1:1 mixture of HEMA-co-DEAEMA was used. The elemental composition of the coatings was characterized by X-ray photoelectron spectroscopy (XPS) along with ATR-FTIR spectroscopy that provided additional information on the chemical binding and functional groups. Furthermore, the wettability and streaming potential of the deposits were determined by surface energy and zeta potential measurements, respectively.

Results and discussion:

Figure 1 shows a plasma-polymerized hydrogel coating on a silicon wafer. The main elements detected on this surface by XPS are carbon, oxygen, and nitrogen. FTIR and XPS measurements reveal a variety of functional groups including: -C=O, -C-O-, -NH, and -OH. In addition, the streaming potential of -60 mV (at pH 7) and 30 mV (at pH 4) indicates the presence of charged, functional groups. The polymerized films demonstrate good stability in water at pH 7, thus under physiological conditions. A water contact angle of $\sim 40^\circ \pm 1.5^\circ$ and a surface free energy of 50 mN/m^{-1} with a polar fraction of 27 mN/m^{-1} confirms the hydrophilic character of the deposits.



Fig. 1: Photograph of the hydrogel coating.

Conclusion:

The results demonstrate that the plasma polymerization of HEMA:DEAEMA, is a prospective technique to generate hydrogel coatings in a single-step process. The coatings exhibit excellent properties in terms of long-term stability for biomedical applications like biosensors, implants, and cell-adhesive surfaces.

References:

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