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Effect of low-pressure radio-frequency air plasma on chitosan films

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Film preparation

Chitosan powder (1 g, 1 wt.%) was dissolved in a (0.2 mol L^{-1}, 100 ml) acetic acid solution at a temperature of 22 ± 1 ° C for a day. The resulting solution was cast on freshly cleaved mica substrates (Plano Gmbh, Germany) using spin coating procedure and dried at a temperature of 30 ± 1 ° C and relative humidity of about 20%. Then the films were exposed to 0.5 M NaOH solution for 60 minutes followed by rinsing in deionized water and dried again. According to the certificate of analysis provided by the company, the viscosity of 1 wt.% chitosan solution in 1 vol. % acetic acid is less than 200 cps, and the degree of acetylation is less than 25%. For preparing the solutions we used Mili-Q deionized (DI) water (conductivity 18 Ohm), chemically pure glacial acetic acid, and sodium hydroxide.

Plasma treatment setup

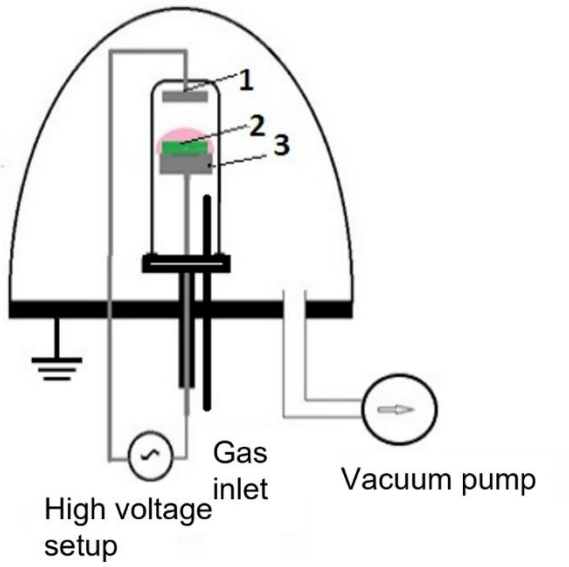

Figure S1. Vacuum chamber with plasma-treatment set up. 1,3-the electrodes, 2-chitosan film mounted on the grounded electrode.

Plasma treatment was carried out in gas-discharge glass chamber equipped with a cylindrical stainless steel mesh electrode at the base and a flat aluminum electrode soldered into the top.

A power supply was characterized with the high-voltage discharge frequency of 15±5kHz with output power of 100 W. The working zone was evacuated to a residue pressure of 10 Pa. The plasma source gas corresponded to atmospheric air fed into discharge cylinder via piezoelectric valve. For treatment, chitosan films were mounted on the grounded electrode. Plasma exposure time was 3, 5 or 10 minutes. After plasma treatment, the films were removed from the apparatus and placed in sealed containers.

Characterization methods

FT-IR spectra were collected using Thermo Nicolet Nexus spectrometer equipped with ATR attachment using ZnSe crystal at 2 cm^{-1} resolutions in the region from 4000 to 400 cm^{-1}.

Chemical composition of the films surface before and after plasma treatment was characterized with X-ray photoelectron spectroscopy (XPS). Spectra were acquired with a ThermoFisher Scientific Theta Probe spectrometer using monochromatized Al Kα radiation (1486.6 eV) at an operating power of 150 W of the X-ray tube with a step size of 0.1 eV.

The effect of plasma treatment on the morphology of chitosan films was studied by means of atomic force microscopy (AFM). The MiltiMode Scanning Probe Micrscope with NanoScope IIIa controller was used to take images. The measurements were performed in a tapping mode using a Bruker cantilever at a scanning range of 1 Hz.

Wettability properties of the treated chitosan films were characterized by static contact angle measurements using the sessile drop technique. The measurements were performed at room temperature on RheoDrop setup (Gaia Technologies). Two different test liquids were used: distilled water and diiodomethane. The values of the contact angles are the average of at least 3 measurements.