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バイオイメージング応用のための大気圧マイクロキャピラリープラズマジェットによるポリマー表面への機能化パターン作製

Preparation of Functionalized Patterns on Polymeric Surfaces by Atmospheric Pressure Micro-capillary Plasma Jet for Bioimaging Applications

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This study presents the implementation and evaluation of a technique based on an atmospheric pressure micro-capillary plasma jet, used to produce amine groups functionalized patterns on the surface of various polymeric surfaces. The functional groups are used to enrich specific areas on the polymer surface and though create active sites for further biomolecule immobilization so that these surfaces could be used in bioimaging and biomedical applications.

The technology has two steps: first the polymer surface is activated in a helium discharge and with biasing the substrate under the sample, followed by the addition of amino groups on the activated site, in a discharge ignited in a mixture of helium and ammonia. Different size, shape and spacing are obtained on photoresist film, and polymeric sheets (polyurethane and polyethylene) as function of the plasma parameters but also depending on the processing geometry. For the same treatment time, increasing the pretreatment period will result in a larger areas patterned. This is due to the surface activation taking place during pretreatment, which is very important, fact residing from the measurements of the average diameters of the functionalized areas and explained by the high speed camera images of the discharge when applying bias as compared with the no bias case. The results of patterning are consistent with the imaging of the discharge: the character of the discharge during pretreatment is filamentary (Fig. 1 (a)), its strength cleaning the first layers of the polymeric surface and activating the sites. During the treatment (no bias) the discharge is more like glow type (Fig. 2 (b)), and it furnishes the monomers necessary for the functionalization.

The possibility to further link molecules on the active sites is first proven by fluorescence microscopy where a fluorescent dye is used to specifically connect amine functionalities and then emit fluorescence under proper excitation. Furthermore, fluorescent labeled dextran was used to test the ability of the functionalized pattern to bind biomolecules. Under the fluorescence microscope, the excitation with 495 nm light resulted in a fluorescence image of the labeled dextran bound on the functionalized pattern which appears as a more diffuse pattern as compared to fluorescent dye images (images not shown here), explainable by the large size of dextran molecules and its labeling degree. These and other aspects and results will be more deeply discussed during the conference.

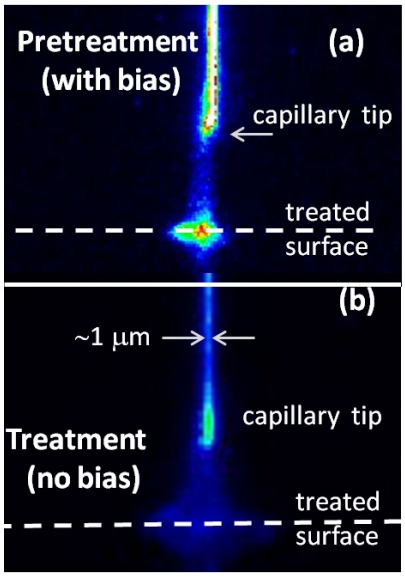

Fig. 1 ICCD camera images of the discharges (a) during pretreatment (with bias), and (b) during treatment (without bias) for the processing of photoresist film.