PHOTOVOLTAIC MANIPULATION ON LN SURFACE: POLYMER, PARTICLES AND BIOLOGICAL SAMPLES

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Interplay between biological samples and Photovoltaic (PV) crystals opens new possibility in smart materials science. Cellular behaviours can be modified by DEP forces on PV surfaces. Living samples actively modify the electric-field inside PV substrates.

Keywords: Ferroelectric Crystals, Photovoltaic trapping, Bio-lensing effect

1. Introduction

Remote activation of surface electric fields (EF) in smart materials is a challenging issue for avoiding integration of different materials and making easier complex and multiple steps in fabrication processes. Activation of electrodes by interaction with light can be realized in photovoltaic (PV) crystals where suitable wavelength and power generate charge displacements and stable space EF. In literature many works describe in detail PV fields in ferroelectric material such as Lithium Niobate (LN) [1,2] and many applications have been demonstrated for dielectrophoretic\electrophoretic (DEP\EP) trapping of microparticles [3,4] and for sensing in microfluidic environment [5]. Also polymer structures have been realized by exploiting evanescent EF on the surface of LN [6]. Recently it has been investigated the interaction of such fields with biological samples thus proving its biocompatibility for tissue growth or for biosensing [7,8]. Here, it will be demonstrated that PV fields can be employed for realizing a ferroelectric interface able to interact with living samples.

2. Results

In Figure 1(a) and (b) DEP trapping for polymer and particles is showed, respectively. PV field are able to shape the PDMS directly on the surface of the crystal thus creating microchannel whose wall are made in PDMS while the bottom side is the crystal itself (Figure 1(a)). In this way the underneath crystal can also activate PV forces to trap particle flowing into the channels (Figure 1(b)). Shaping liquids\polymers directly on the surface of the active material has many advantages, the most important is the avoiding of bonding process of fabrication thus reducing the percentage of leaking at the interfaces. The strength and the physical extension of PV fields allow to extend its applicability also in bio-oriented experiments. In Figure 1(c) it's displayed the trapping and orienting of E. Coli bacteria by light exposure onto iron doped LN. The percentage of alignment changes depending on the characteristic length of the induced space EF, higher alignment percentage is reached when 25μm, and 100μm linear phase gratings are inscribed inside the crystal volume corresponding to similar characteristic lengths for the evanescent fields on the surface. The effect of the evanescent fields on the surface in case of x-cut LN or the exposed charges in case of z-cut LN have an important role also on the adhesion and migration features of adherent cells [8]. Recently, it has been demonstrated another interplay between LN PV property and living sample. Indeed, in Ref. [9] it has been demonstrated that living Red Blood Cells are able to locally modify the refractive index of the Fe:LN thus realizing a sort of bio-photolitography.

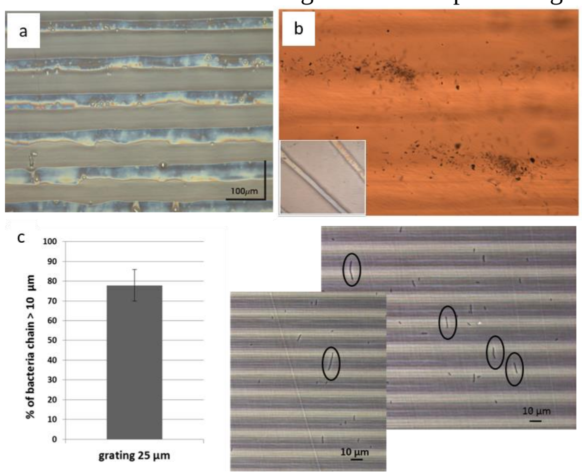

Fig. 1 PV trapping of PDMS on LN surface thus creating all-optical fabricated microchannels. (b) the bottom side of the channel is still made by the LN crystal that behaves as active material to trap particle flowing inside. Also in this case the trapping is induced optically. (c) Immobilization and orientation of bacteria under the PV fields.

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