Effect asymmetry of diffraction efficiency in LC cells with different command surfaces

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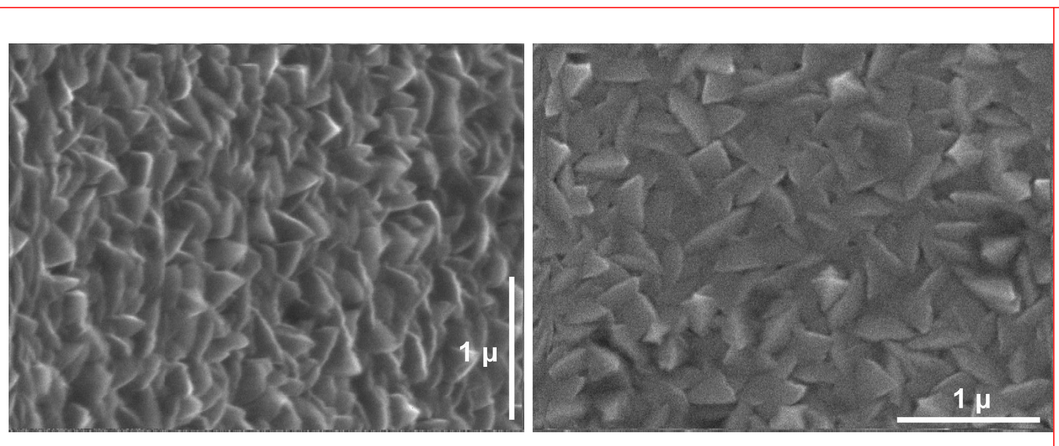
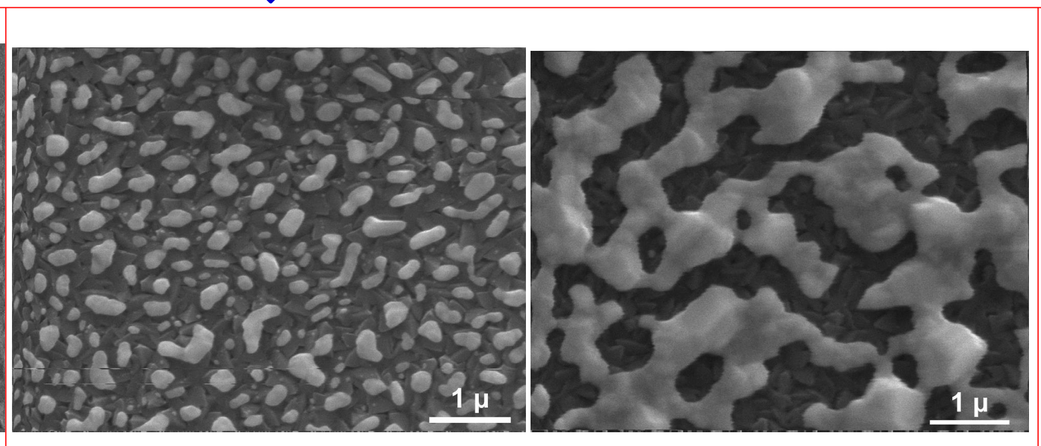
Abstract: We report new results on the measurement of the diffraction efficiency in liquid crystal (LC) cells with different orienting surfaces in the presence of a dc electric field. Diffraction gratings were recorded in combined cells with E7 liquid crystal. We used LC cells with thickness ~10 μm. Gold, ITO and chalcogenide micro-surfaces were used as command surfaces. Diffraction gratings were formed by 2-beam irradiation of LC cells by spatially modulated laser light (λ = 532 nm) with linear p-polarizations. As a result, we found an asymmetry in the diffraction efficiency of the recorded gratings depending on the type of command surface and the sign of the applied voltage.

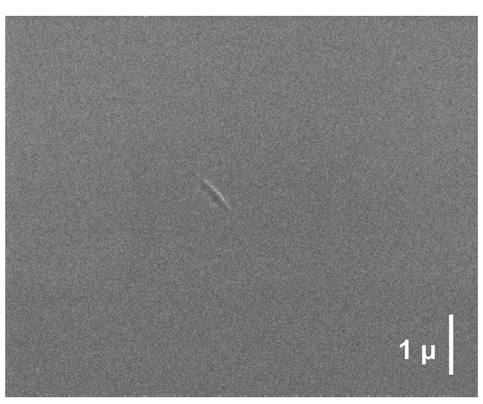
Investigated surfaces (SEM)



ITO surfaces

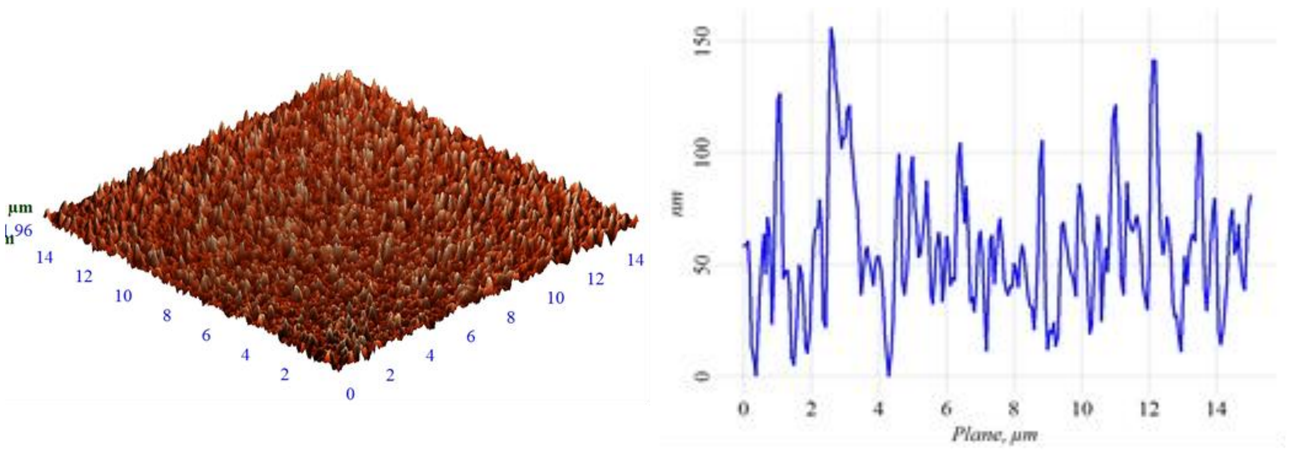


Island gold surfaces



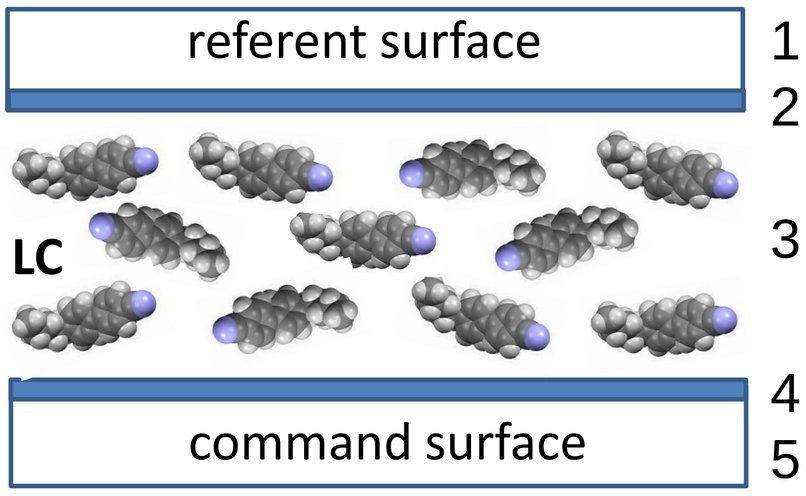
Chalcogenide surface

AFM measurements:



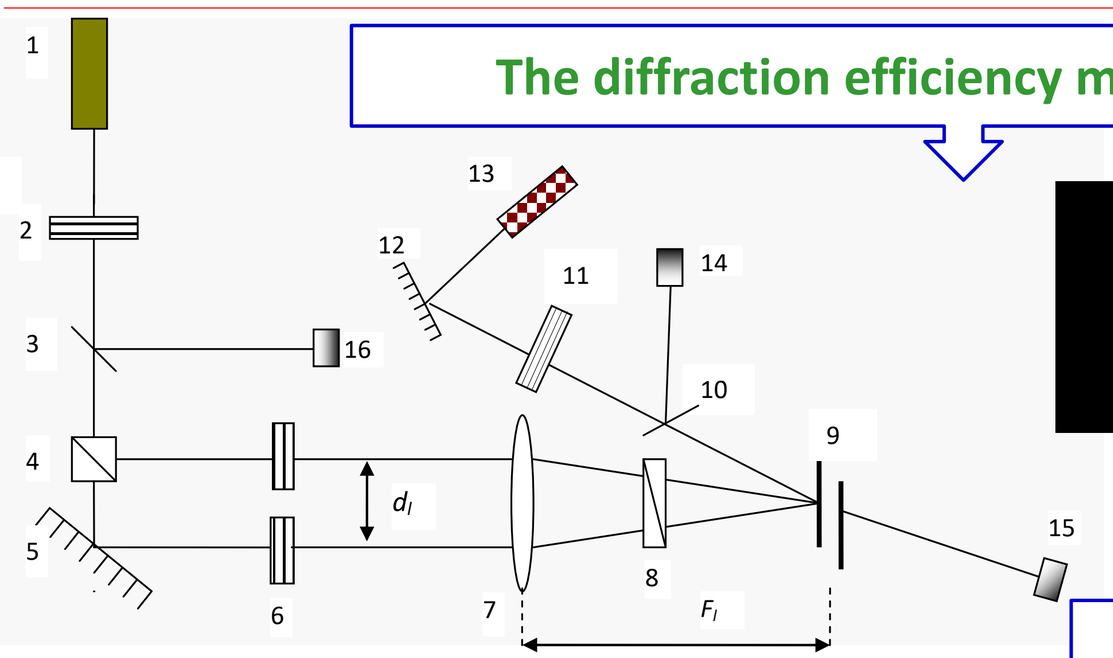
Atomic Force Microscope results for island gold surface

Liquid crystal cell preparation:



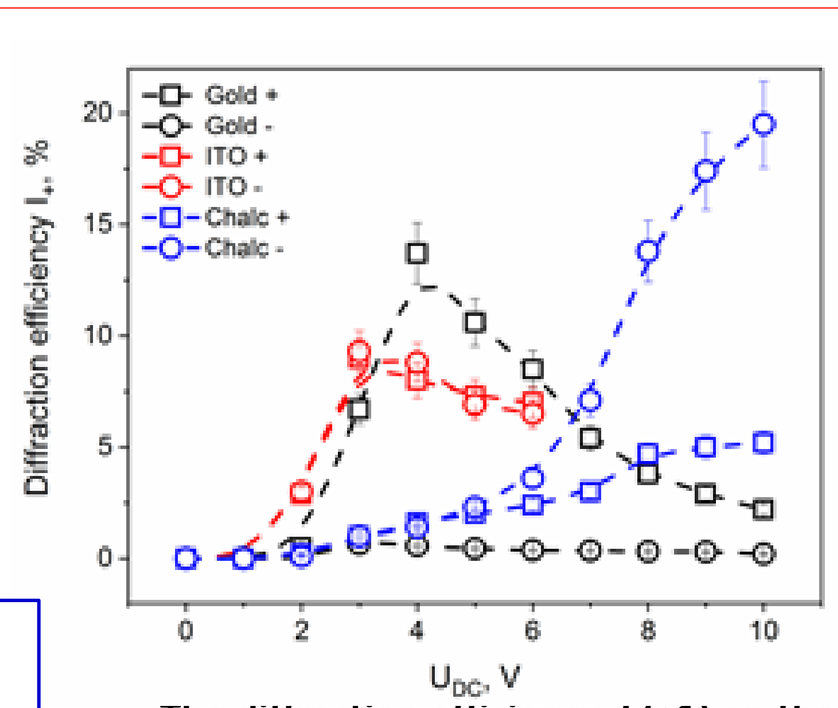
Scheme of LC cell: 1;5-glass substrate, 2 – referent layer; 3 – liquid crystal; 4 – command layer (ITO, nano-gold island, chalcogenide)

The diffraction efficiency measurements:



Experimental set-up: 1 – DPS Laser (λ = 532 nm); 2– λ/2-waveplates; 3, 10 – beam-splitter plates; 4 – beam-splitter cube; 5, 12 – mirrors; 6, 8, 11 – polarizer; 7 – lens; 9 – sample; 13 – He-Ne laser (λ = 632.8 nm); 14, 15, 16 – photodiodes.

Diffraction patterns from LC combine cell



The diffraction efficiency I (+1) on the applied voltage

Conclusions:

In summary, we have carried out experiments that indicate a surface-charge-mediated photorefractive effect in pure liquid crystal aligned on conductive ITO electrodes, gold and chalcogenide nano-surfaces. We suggest that interfering beams modulate the distribution of the charges in the layer of LC molecules adsorbed by investigation surfaces. The spatial modulation of charges results in a tangential component of the dc-field applied to the cell, which, in turn, re-arranges LC molecules ordering in the adsorbed layer. Re-arrangement of the ordering results in modulation of the easy axis and surface angular torque in the LC bulk, which finally results in the grating recording.

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