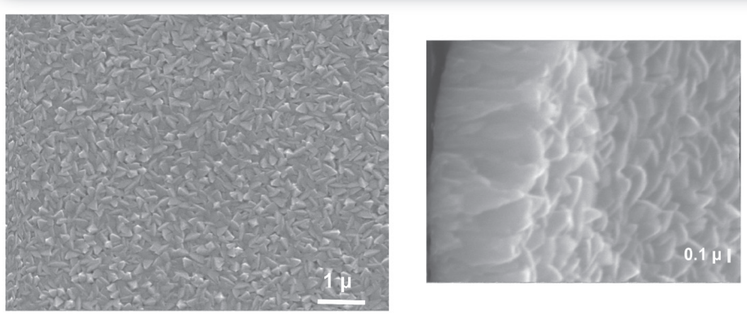
Electro-optical properties of hybrid LC materials containing photo-controlled inorganic-organic interface

S.Bugaychuk[1,2], Yu.Kurioz[1], A.Gridyakina[3], J.Parka[4], L.Fedorenko[5,6], A.Evtukh[5], S.Kredentser[1], V.Pinchuk[1], P.Onyfrijevs[6]

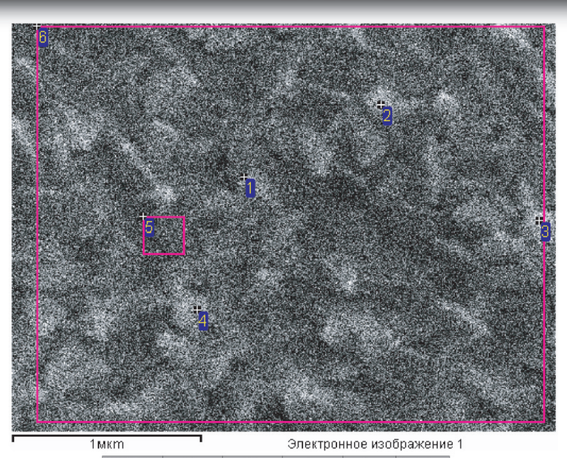
1) Institute of Physics, Ukraine 3) Warsaw Univeristy of Technology 4) Military University of Technology, Poland
2) University of Lille, France 5) Institute of Semiconductor Physics, Ukraine 6) Riga Technical University, Latvia

Abstract: By applying the dynamic holography method with two-wave mixing, we have revealed the nonlinear optical effect in hybrid LC cells. It is a new type of electro-optical liquid crystal cells offered by us, which contain a gold island film covered an ITO electrod. The cell consists of two glass plate with ITO electrode between which is 20-μm homeotropic layer of a liquid crystal. We carry our structural analysis of ITO surface and ITO-gold island surface, spectral analysis, and study the nonlinear optical response,which is arisen due to mechanism of surface-induced photorefractive effect.

ITO has a developed surface (SEM images)

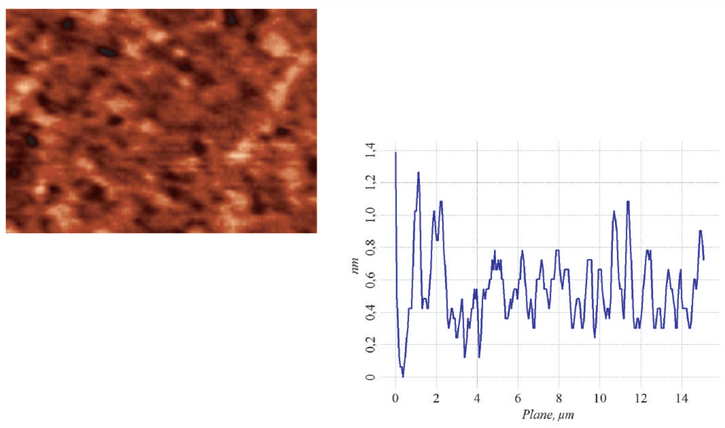


Gold island film on ITO surface (SEM images)

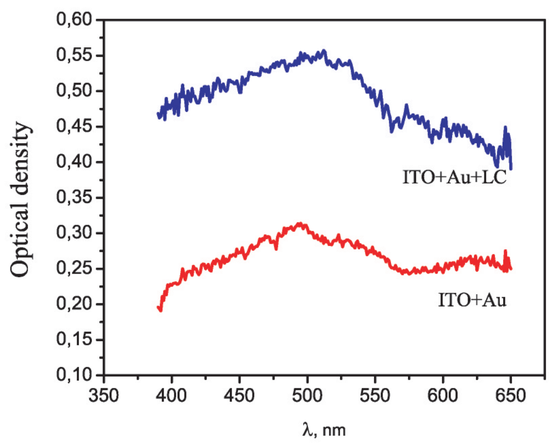


Spectrum	O	Si	In	Au	Total
1	18.34	1.45	78.45	1.77	100.00
2	18.80	1.09	75.73	4.37	100.00
3	17.42	0.78	81.32	0.48	100.00
4	16.28	1.09	80.45	2.18	100.00
5	23.75	0.69	75.56	0.00	100.00
6	19.47	0.71	79.81	0.00	100.00
Max.	23.75	1.45	81.32	4.37	
Min.	16.28	0.69	75.56	0.00	

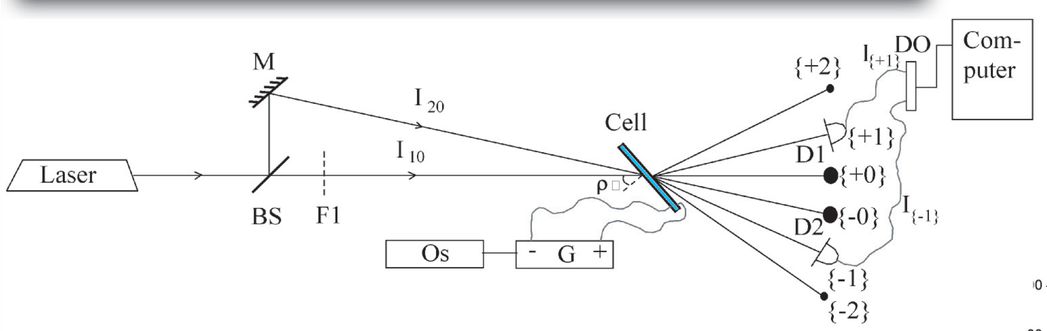
AFM image of smooth ITO surface



Optical spectra exhibit surface plasmon resonance in gold NPs

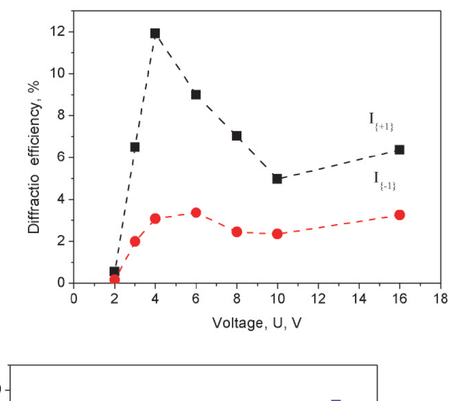


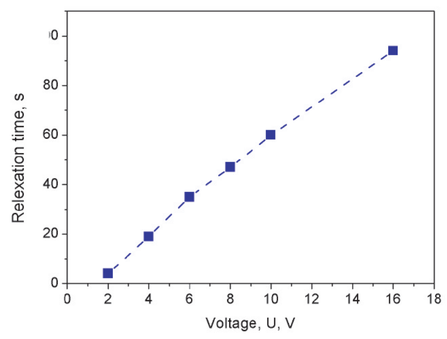
Two-wave mixing experiments with hybrid LC cells containing Au NPs



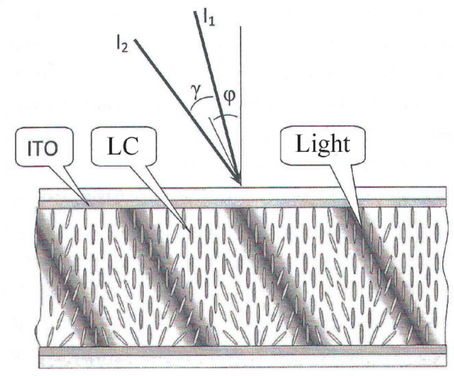
Laser - YAG:Nd, continuous,
λ=532 nm, P=50 mW

ρ=45 is angle of sample normal towards to bisector of light beams

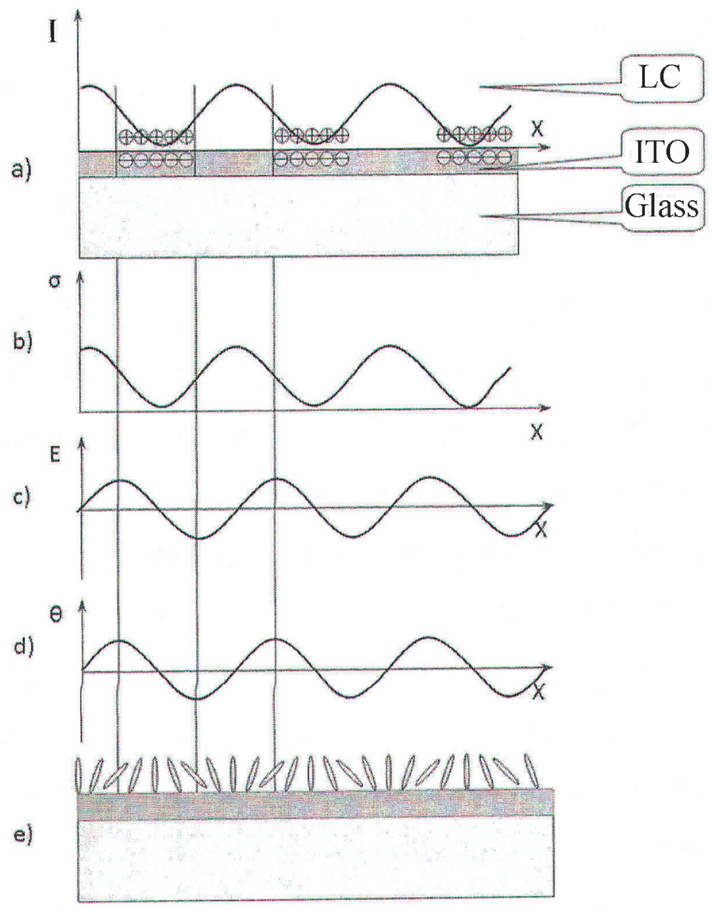




Surface-induced photorefractive effect in pure nematic LC



Surface-induced orientation nonlinearity in bulk LC



- Desorption of charge from surface to LC bulk under action of light interference pattern
- Formation of space distribution of charge in the interface LC-ITO
- Creation of space periodic distribution of electric field by unstable charge
- Periodic modulation of the director on the surface of the substrate (**d** || **E**)
- Reorientation of molecules which comes from the surface to the volume

Conclusion:

- Hybrid LC cells with gold island films are studied for the first time.
- The photorefractive mechanism of optical nonlinearity is due to generation of spatially inhomogeneous unstable charge on the interface ITO-gold island film-LC.
- A sufficently large nonlinear response and its dynamic nature allows our cells to be used for practical purposes in electro-optical systems.

References:

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