# Effect of polymer-coated gold nanoparticles on the flexoelectricity in planar thin films of pentylcyanobiphenyl (5CB) nematic liquid crystals

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The flexoelectricity in planar thin films of nematic liquid crystals pentylcyanobiphenyl (5CB) containing gold nanoparticles (AuNPs) were studied. Polymer-coated nanospheres of AuNPs with a mean diameter of 20 nm were dispersed in 5CB at a concentration of 0.5 wt%. AuNPs/5CB nanocomposite films with a thickness of 25 μm were characterized by polarizing optical microscopy and flexo-dielelectro-optical spectroscopy.

**Aim**: In the study presented here, we examine the flexoelectric origin of the electro-optical modulation in AuNPs/5CB nanocomposite nematic system. To study the effect from AuNPs, our interest was concentrated on the first harmonic electro-optical spectra of above nematic nanocomposite.

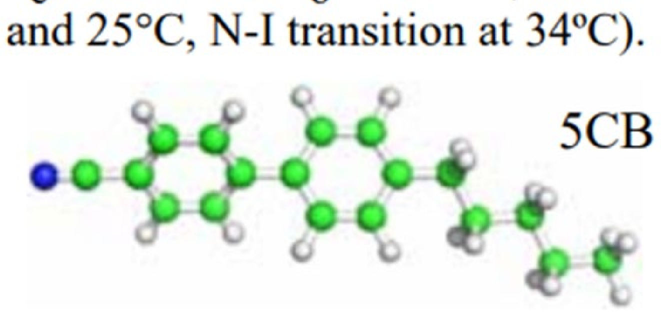
## Introduction:

The flexoelectricity [1] providing linear coupling is a phenomena that take place in liquid crystal systems. If the nematic molecules are slightly pear shaped and exhibit a longitudinal permanent dipole, like the cyanobiphenyls, an applied field not only orients the nematic director along the field direction but also causes a slight splay distortion of the director field. The most important aspect of this effect is that positive and negative voltages cause opposite splays, creating a first harmonic electro-optic response [2,3]. Currently the flexoelectric effects in NLCs-based composites have not been investigated systematically.

## Materials :

***The film:*** **nanocomposite** of AuNPs in nematic 5CB (thickness 25 μm)

***LC:*** Nematic 5CB (from Merck), $n_e$=1.706 and $n_o$= 1.532 (λ = 633 nm and 25°C, N-I transition at 34°C).




***AuNPs:*** spherical-shaped AuNPs (mean diameter ~ 12 nm);
polymer-capped AuNPs: (mean diameter ~ 25 nm)
AuNPs concentration ~ 0.5 wt.%

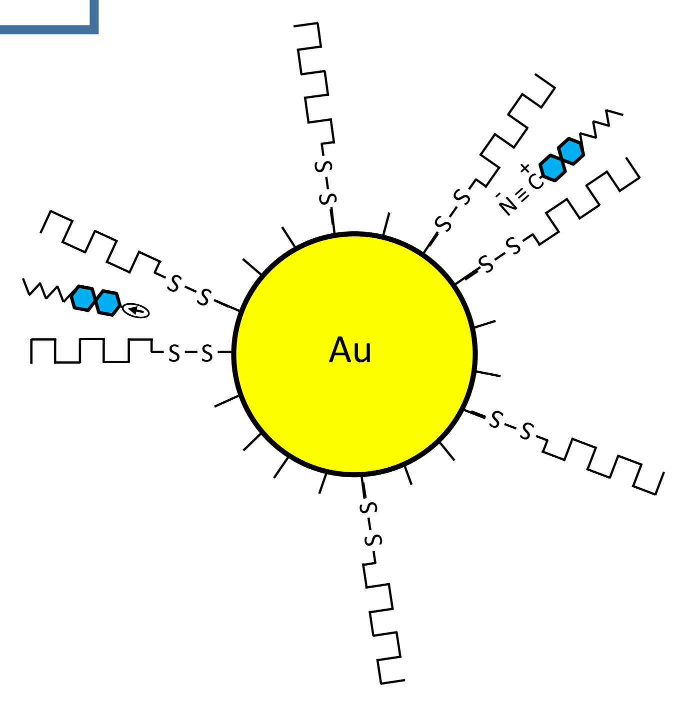



Figure. 5CB nematic molecules in the solvation shell of an Au nanoparticle are shown. To prevent tAuNPs aggregation, and thereby to ensure a good solubility and a homogeneous mixture of AuNPs in LC, the NPs were capped with polymer chains of random copolymers of oligo(ethylene glycol) methyl methacrylates, disulfide-functionalized, 25 nm diam.

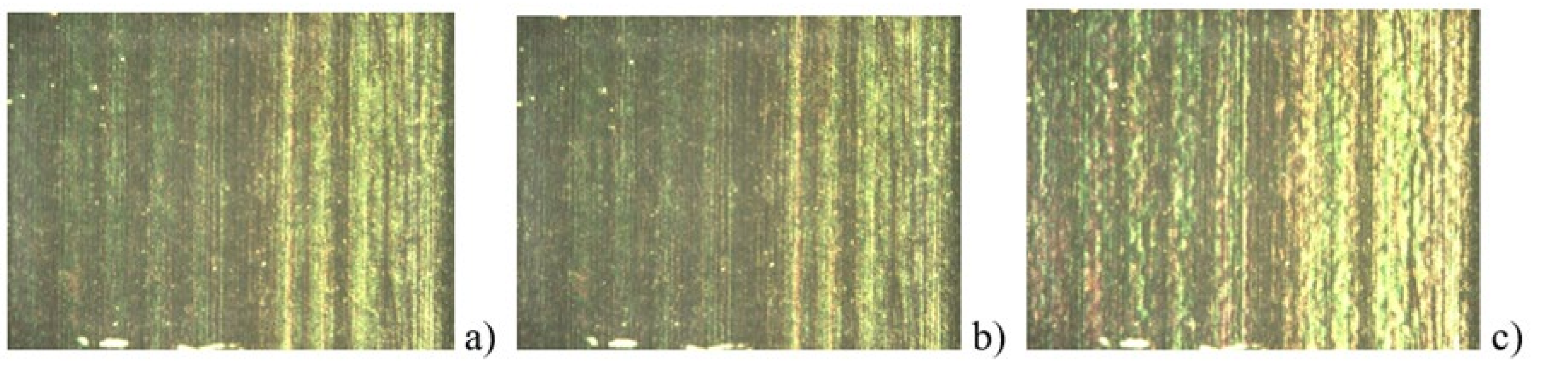



Figure 1. Micrographs under crossed polarizers of 5CB planar nematic film (25 μm): a) 0 $V_{dc}$, b) 2 $V_{dc}$ field is applied normal to the layer, c) fast switching off to 0 $V_{dc}$.

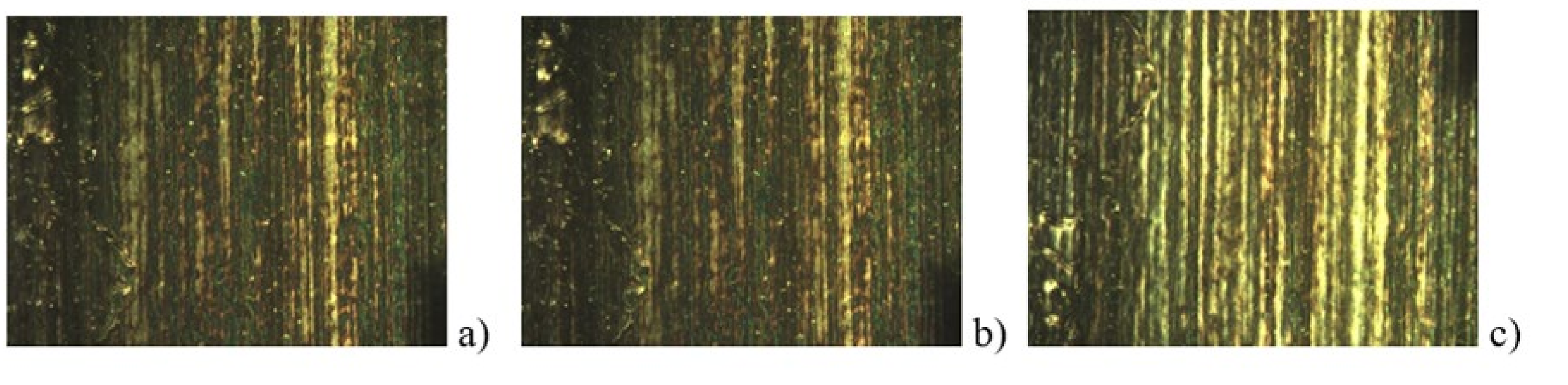



Figure 2. Micrographs under crossed polarizers of 5CB/Gold planar nematic film (25 μm): a) 0 $V_{dc}$, b) 2 $V_{dc}$ field is applied normal to the layer, b) off fast switching to 0 $V_{dc}$. Room temperature.

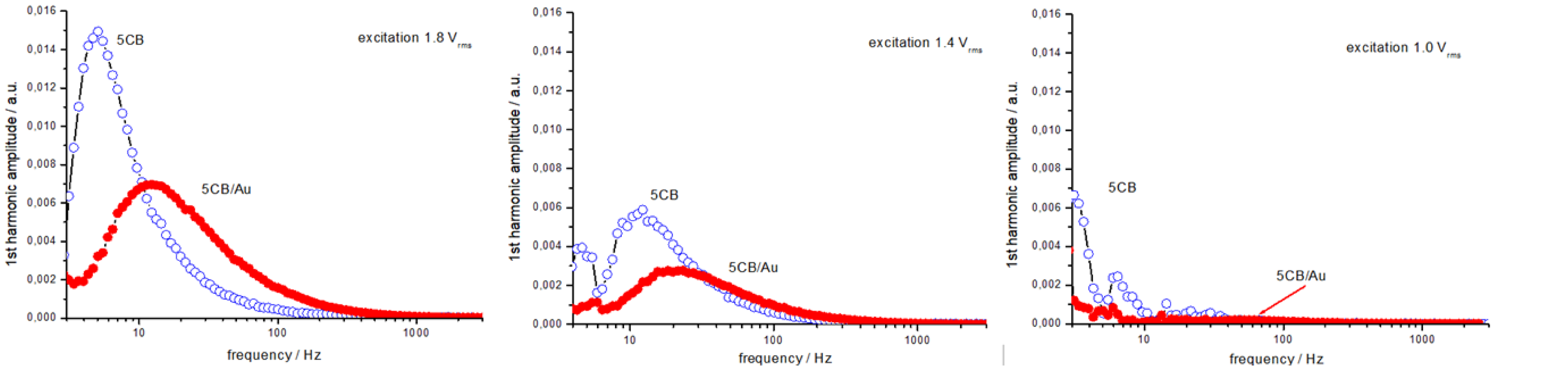



Figure 3. Frequency spectrum of the amplitude of the 1st harmonics of polarized light transmitted through the samples at crossed polarizers and various applied voltages. Hollow symbols are for 5CB, full symbols are for 5CB/AuNPs composite. ).

**Conclusions: The results show that: 1) the nanostructuring of NLC reduces the amplitude of first harmonic of the modulated light (relevant to the flexoelectric deformations) and should be associated with a reduced degree of the nematic order;**
**2) the maximum frequency of the first harmonic peak of the AC voltage-dependent optical transmittance of AuNPs/5CB planar thin films is dependent on the amplitude of the driving electric field.**

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**References:**
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