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Effects of CuO/Zn Nanoparticles in Polymer Dispersed Liquid Crystals

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ABSTRACT

PVA based CuO/Zn nanoparticles doped liquid crystals are formed by solvent induced phase separation method (SIPS). Structural, electrical and optical characterization of inorganic nanoparticles doped PDLC are studied. The presence of liquid crystal and nanoparticles in PVA Matrix were conformed and the modified properties of PDLC due to doped nanoparticle were studied and explained by the results of FTIR, SEM, UV, TG/DTA dielectric measurement, Conductivity measurement, and the Cole Cole plot. Incorporation of nano particles modifies the structure of PDLC and thus it makes increase in the amount of droplets and decrease in droplet size, as well as improves the electrical conductivity.

Key words: PVA (poly vinyl alcohol), Nano oxides, PDLC (poly disperesed liquid crysatal).

INTRODUCTION

Recently polymer dispersed liquid crystals are used as display materials in monitor screens and other type of displays, this is because of the RI (Refractive Index) properties of liquid crystals, liquid crystals have high RI properties in lower voltage and also it have two basic effects electrically controlled birefringence and electrically controlled light scattering .liquid crystal are highly transparent in the visible and near infrared wavelength regions [1, 2]. A PDLC is a film of liquid crystals dispersed in polymer matrix, the dispersion of liquid crystals dispersed in polymer matrix from fractions of micrometers up to several micrometers. Depend upon the polymer and liquid crystals it has different type of RI and light scattering properties. The light-scattering factor of liquid crystals can change with change in molecular orientation for applied electric field [3, 8,12].Polymer dispersed liquid crystals are used for display films because of the different useful properties; the higher mechanical strength and flexible character of PDLC is used to produce large size thin films displays [3,4]. Display can be divided into two type Projection display and direct view display. The displays made by polymer dispersed nematic liquid crystal are mostly used as direct view display [5,6]. Polymer dispersed liquid crystals are best materials for reflective and projection displays, window shutters, and holographic recording media due to their low cost and ease to processing [7]. PDLCs are currently considered as promising materials for specific applications such as creation of window blinds controlled by electric field, fog simulators, UV protective glasses, ,high data storage device etc[8,9]. We know that the electrical field inside the liquid crystals is low compare with the external electrical field. An addition of high magnetic and electrical properties containing compounds to the polymer dispersed liquid crystals (PDLC) will enhance the electrical, optical , photovoltaic and magnetic properties of the PDLC [9, 10,11].The addition of Nanoparticles to the PDLC will also increase the light scattering properties of the PDLC. And the light scattering properties of the PDLC is also depends on the size of Nanoparticles and Liquid crystals droplet [9].

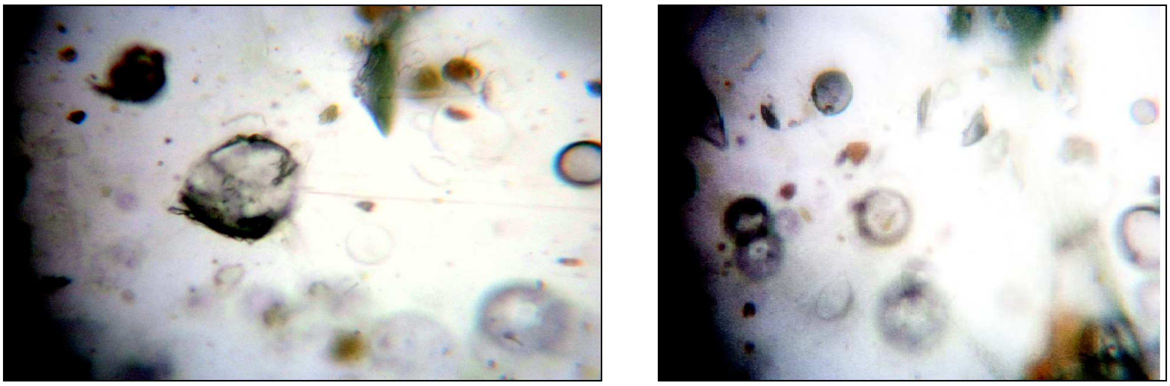
MATERIALS AND METHODS

The sample of PDLC has been prepared by the following method. A clear solution of Poly vinyl alcohol (PVA) is prepared by 10 ml of DMSO (Dimethyl sulfoxide) with 2.5 g of PVA. The 0.5 g of the Phenyl benzoate liquid crystals is added to PVA solution with continues starring. The nanoparticles are also added to the solution with continues stirring. The thin film is made evaporating the excess solvent by pour the sample solution in petri dish and dried it in sunlight.

RESULTS AND DISCUSSION

3.1 Structural Studies

The OLYMPUS 51 optical microscope image for pure and CuO/Zn doped PDLC films are given in fig 1.The image given in Fig.1 shows the complete view of the dispersion of nanoparticles and Liquid crystals in Polymer matrix. The cavity and small size dots are the maters belongs to liquid crystals and nanoparticles respectively. Besides, the cavities, which are the traces of LC droplets, do not contain nanoparticles or their aggregates.



1A) Zndoped- PDLC *1B) CuO doped -PDLC*

Fig: 1 Optical microscopy image for Undoped PDLC (a) and Zn/CuO NP Doped PDLC (b and c)

3.2 FT-IR

The FT-IR image for CuO/Zn doped PDLC are shown in the following fig.2.And the presence of presence of phenyl liquid crystals are conformed by the peak at near 3500 cm^{-1} range.

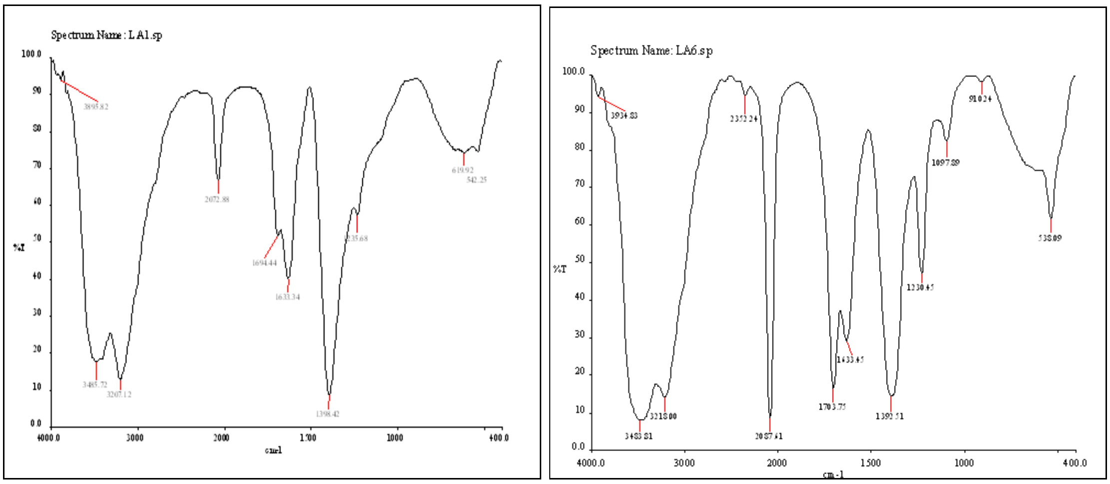
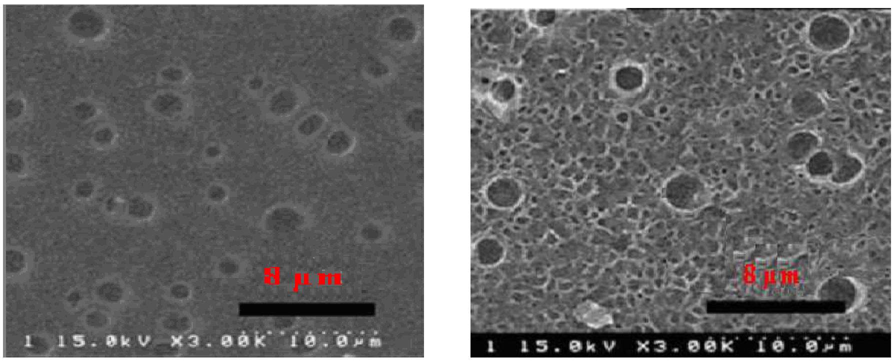


Fig: 2 FT-IR image for CuO/Zn doped PDLC



3B) ZnO doped- PDLC *3C) CuO doped -PDLC*

Fig: 3 SEM image for (a) Pure PDLC and (b) Zn and (c) CuO NP doped PDLC

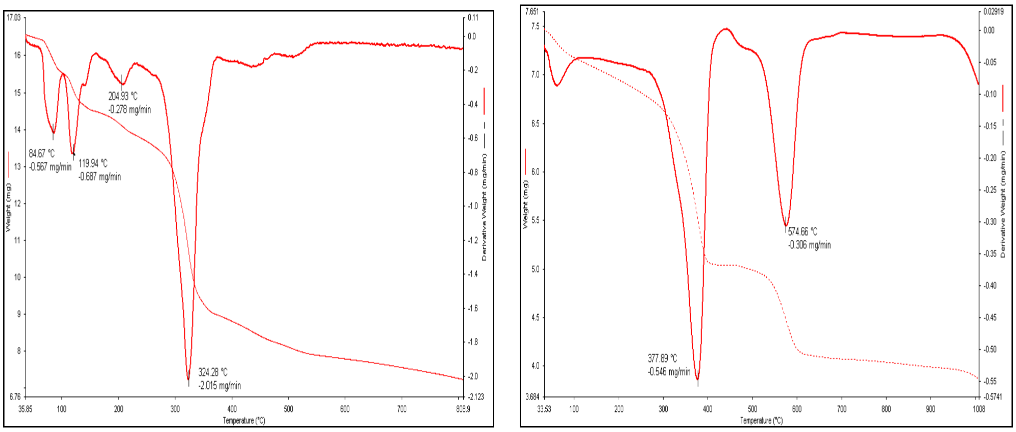


Fig:4 TG/DTA graph for CuO/Zn Nanoparticles doped PDLC

3.3 SEM

The SEM image of Pure and Zn/CuO doped PDLC for the synthesized samples are shown in the fig. 3 .From the SEM image picture out the clear view of the dispersion of the liquid crystals and the nanoparticles in the poly vinyl alcohol matrix. But NP does not distort notably PDLC. morphology.

3.4 TG / DTA Analysis

The TGA/DTA graphs for the pure and Zn/CuO Nanoparticles doped PDLC are shown in the fig. 4.From these result we can find the thermal Zn/CuO doped PDLC stability of the prepared samples.

3.5 UV Spectroscopy

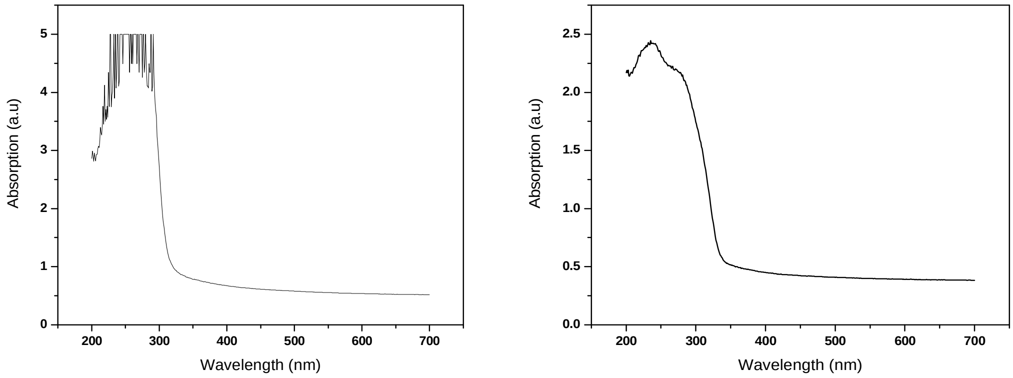


Fig:5 UV-Visible spectra for Pure and Zn and CuO doped PDLC.

The Optical absorption spectrum (UV) for pure and nano-particle dispersed PDLC is represented in the following fig. 5.The absorption peak nearby 240nm, 340nm and 360nm reveals the presence of PDLC, CuO and Cu Nanoparticles respectively.

3.6 Dielectric Measurements

The following Fig. 6 -13 shows the frequency dependence of dielectric properties of pure polymer dispersed liquid crystals, Zn doped PDLC and CuO doped nanoparticles respectively. PDLC sheets cut into small circles of diameter 12mm are used for electrical measurements. The greatest difference between the sample in the ε' value is measured for different frequency $f < 10^2$ Hz at various temperature. The graph for different frequency range show the sharp increasing permittivity of the compounds this is caused by redistribution of the electric field due to near-electrode processes. For non-uniform electric field, the ε′ value can be considered as the effective one. From these analyses we can conclude that increasing permittivity is higher for CuO doped PDLC than Zn doped PDLC for near-electrode area. From the figures shown below have greater difference in the ε′ magnitude is higher for the nanoparticles doped PDLC that conclude that the effective value of permittivity is increases by the addition of the nanoparticles and liquid crystals to the polymer matrix. And from this result we conclude that the addition of the nanoparticles into a PDLC lead to an increase in the amount of liquid crystal in the near-electrode area [7].

$$\sigma_e = \sigma_{DC} + A\omega^s. \qquad (1)$$

Comparison of the σ_i value for the films of pure and nano doped PDLC. The following figure shows that the addition of the nanoparticles increases the σ_i value.

$$\sigma = \sigma_i + \sigma_{DC} + A\omega^s. \quad (2)$$

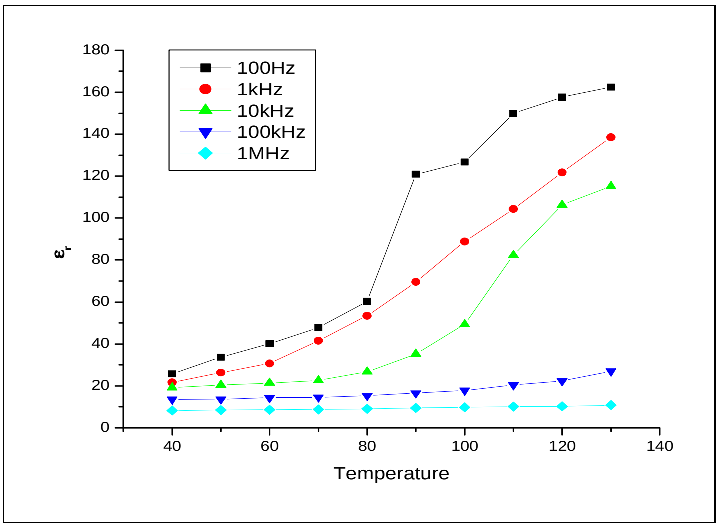


Fig 6 : Variation of dielectric constant with temperature for CuO doped PDLC for various frequencies

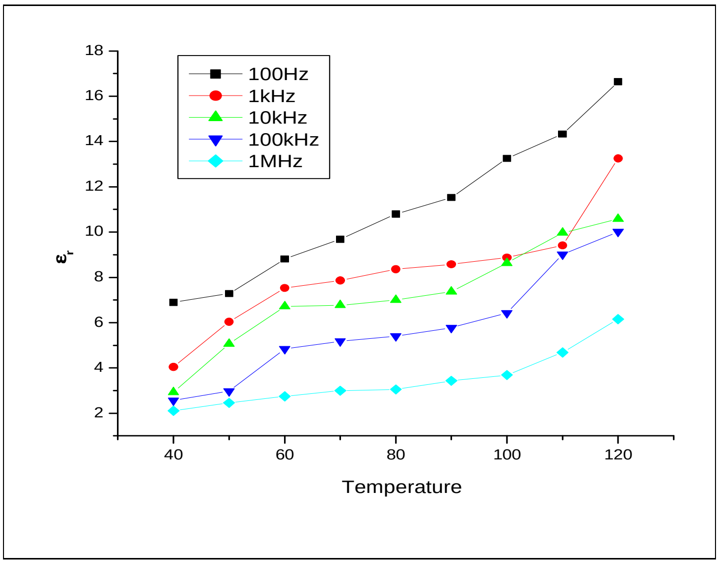


Fig 7 : Variation of dielectric constant with temperature for Zn doped PDLC for various frequencies

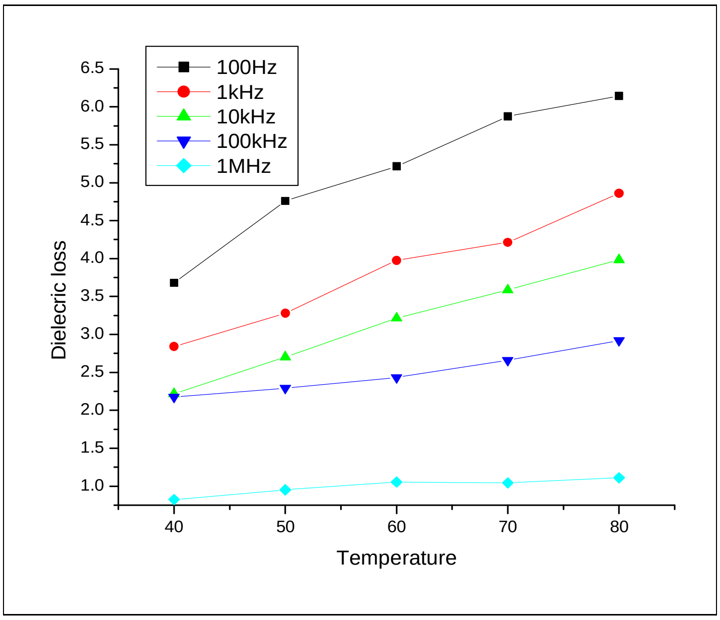


Fig 8 : Variation of dielectric loss with temperature for CuO doped PDLC for various frequencies

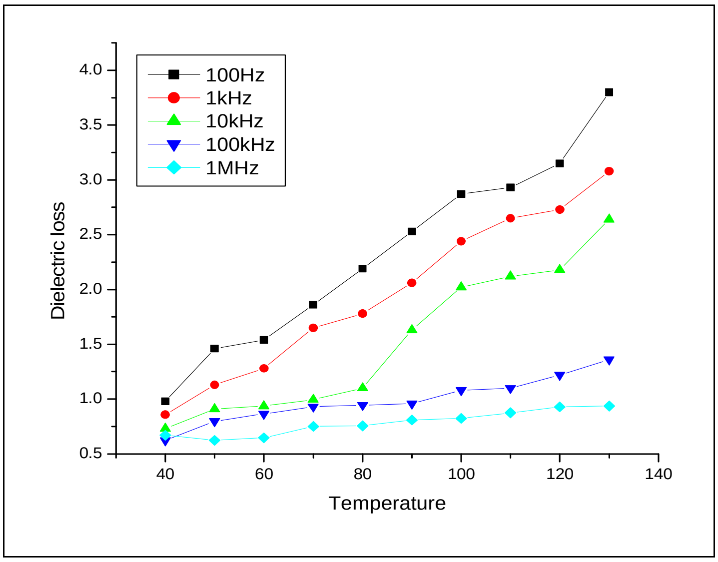


Fig 9 : Variation of dielectric loss with temperature for Zn doped PDLC for various frequencies

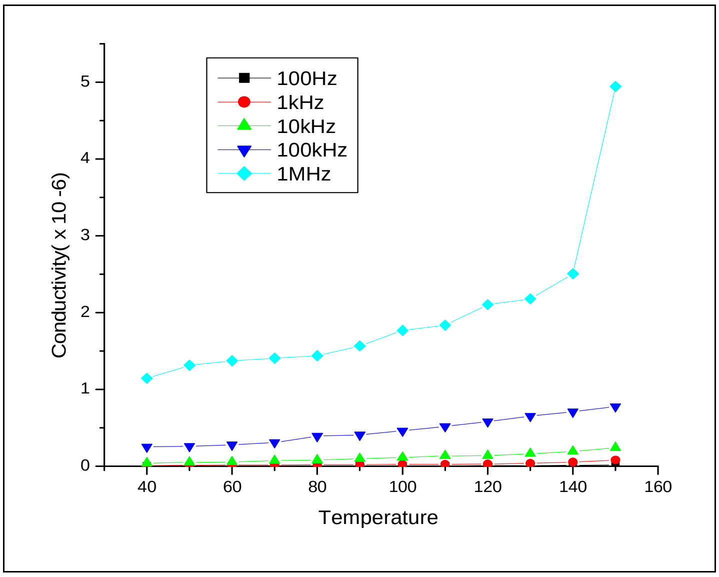


Fig 10 : Variation of AC conductivity with temperature for CuO doped PDLC for various frequencies

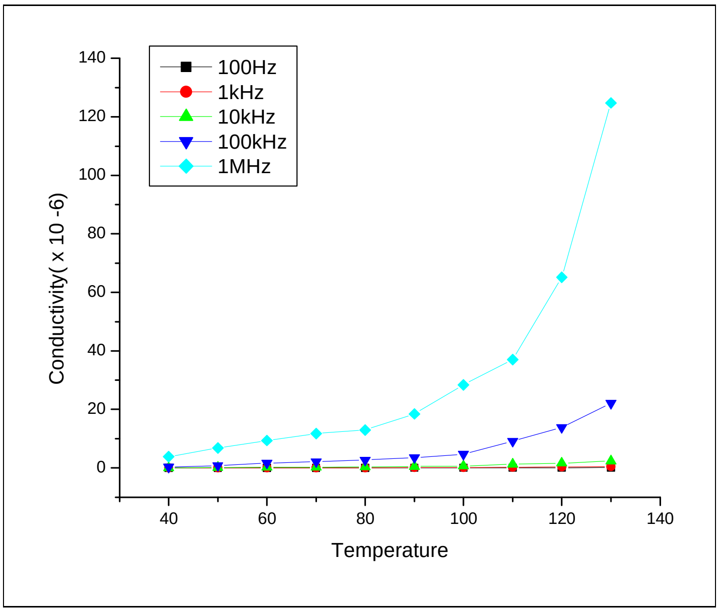


Fig 11 : Variation of AC conductivity with temperature for Zn doped PDLC for various frequencies

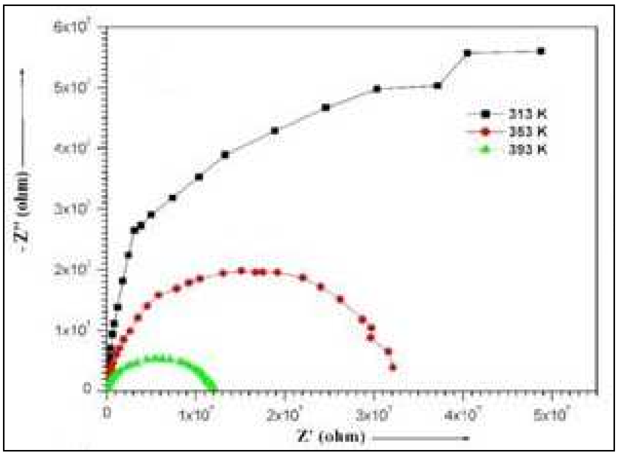


Fig 12: Cole-Cole Plot for CuO NP doped PDLC

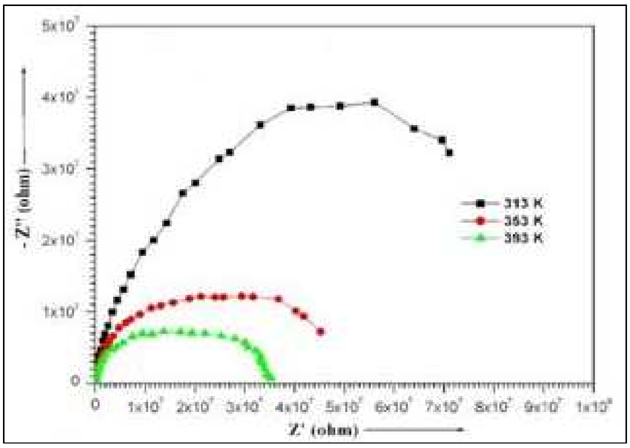


Fig 13: Cole-Cole Plot for Zn NP doped PDLC

CONCLUSION

The addition of nanoparticles and liquid crystals to the polyvinyl alcohol matrix will change the nature of polyvinyl alcohol this can viewed by the above discussions. The introduction of Nanoparticles to the PDLC film will increases the amount of droplets and decrease in droplet sizes. And that the increasing permittivity is higher for CuO doped PDLC than Zn doped PDLC for near-electrode area from this results we conclude that the CuO doped PDLC has a better usage in electrical and electronic devices than Zn doped PDLC samples.

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