Abstract: We demonstrate the effect of the ferroelectric nanoparticles dispersed in the alignment layer of a TN LC panel. The TN LC panel with alignment layer doped with ferroelectric nanoparticles shows much higher contrast ratio in comparison to the ordinary TN LC panel with commonly used polymide layer. The effects of BTO nanoparticles in several different concentrations have been studied. Among which 2.5 wt% and 5 wt% BTO mixtures show better performances. Higher concentrations as 10wt%, 15wt%, and 20wt% have also been studied. No improvement has been found in these cases. Surface textures of the alignment layers have also been studied by AFM. Nematic liquid crystal ZLI-4792 has been used for this study.

Introduction: Since the past few decades LCDs have taken the lead in the growth of the display market. Manufacturers are interested in improving the technology of LCD operation while at the same time making production easier. The alignment layer in the LCD panels plays an important role in controlling the contrast ratio and viewing angle by modifying the pre-tilt angle. So research of the alignment layer is a noble research area for the LCD display researchers. The nematic liquid crystal material ZLI – 4792 has been used in this research work. SE 130 has been used as the aligning agent. The prime object has been to study the effect of dispersed BTO nanoparticles in the polyimide. BTO (barium titanate) nanoparticles of size 50nm has been dispersed in the polyimide medium in different ratios and TN cells have been prepared with thickness 5micron. It has been observed that 2.5 % and 5% BTO enhances the contrast ratio nearly 40% and 100% respectively in comparison to that of using ordinary SE 130. The study has been repeated several times including as well for several cells and the statistical distribution has been studied to confirm its reliability. AFM pictures of the surface of alignment layers using ordinary polyimide as well as BTO doped polyimide have been taken. The results are discussed later.

Experimental: Several mixtures have been prepared with BTO concentration of 2.5%, 5%, 10%, 15% and 20%. All concentrations have been calculated with respect to the weight of polyimide. In the presentation only the result of 2.5% BTO and 5% BTO mixtures to the PI solution have been incorporated. The higher percentage of BTO did not yield any better response. The TN cells have been fabricated in clean room environment. The measurement of VT characteristics has been performed using LCD 5200. The contrast ratio has been calculated from the VT data. In every case several panels have been measured and a statistical survey has also been performed. The standard deviation data has also been incorporated. To study the surface morphology the AFM pictures have been taken using SPA300 (SEIKO Instruments, Inc.).

Results and Discussions: The VT characteristics have been studied by using LCD 5200 for pristine SE130 polyimide as well as BTO doped SE130 in different weight percentages. In each case several TN panels have been studied to get the statistical distribution for the confirmation of its consistency in performance. It has been found that in case of 2.5% and 5% BTO polyimide the contrast ratio has been enhanced remarkably. Fig. 1 shows the change of contrast ratios with the doping concentration of BTO nanoparticles. The standard deviation data has also been incorporated. Fig. 2 shows the value of transmission at higher applied voltages. We can
clearly see the changes of transmission data with different concentrations as well. At such lower value of transmission a little change may easily cause a high jump in the contrast value. So the standard deviation value is higher in this region.

![Graph showing contrast ratio with applied bias](image1)

**Fig. 1:** The variation of contrast ratio with applied bias in three samples.

![Graph showing transmittance of SE130, 2.5% BTO and 5% BTO doped TNLCD panels](image2)

**Fig. 2:** The fig shows the transmittance of SE130, 2.5% BTO and 5% BTO doped TNLCD panels at the higher bias region, indicating the clear difference in the contrast ratio.

![Surface morphology of pure PI coated and 5% BTO coated ITO plates](image3)

**Fig. 3:** Show the surface morphology of the rubbed polyimide coatings on the ITO coated plates. (a) Shows that of pure polyimide and (b) shows that 5% BTO doped polyimide. In the later figure one can easily observe the change in roughness.

The same type of experiment has been performed using some other metal oxide nanoparticles and in all other cases the contrast value decreased or remained almost unchanged. Only in 2.5% and 5% BTO nanoparticles doped alignment layers, contrast value has been increased remarkably. The fig. 3 (a) and (b) show the surface morphology of the pure PI coated and 5% BTO coated ITO plates. In both the cases the pictures of rubbed surfaces have been given. In case of 5% BTO doped surface the surface roughness has been increased.