Strains of LCD panels accumulated during manufacturing and shipping processes and light leakage thereof

Ki-Yong Park[2], Jang-Kun Song[1]
[1] School of Electronic & Electrical Engineering, Sungkyunkwan Univ., Suwon , Gyeonggi-do 440-746, Korea
Tel.:82-31-299-4599, E-mail: jk.song@skku.edu
[2]Dept. of Semiconductor Display Engineering, Sungkyunkwan Univ., Suwon , Gyeonggi-do 440-746, Korea
Tel.:82-41-535-3556, E-mail: park71520@skku.edu

Light leakage can arise from the accumulated strains of LCD panels that are caused by various stresses imposed during manufacturing, shipping and storing the LCD panels. The strains usually make an LCD panel bend locally or globally and when the panel bending exceeds a certain level, undesirable light leakage increases dramatically.

In this presentation, we clarify the origin of the panel strains and the mechanisms for the strain-induced light leakage, and we also propose several ways to soothe this issue. To clarify the causes of the panel bending, we systematically examined the accumulation of panel bending during full LCD manufacturing and shipping processes by dividing the full processes into several sub steps of bare glass stage, assembled panel stage, polarizer-lamination stage, drive-IC bonding stage, and shipping stage. We measured the deformation of panels before and after processing each step, using a 3D laser scanner. In this way, we could quantitatively figure out the accumulation of panel strains during whole manufacturing and shipping processes. We found that the largest panel deformation occurred during shipping and storing panels, which was caused by the restitutional force of elongated polarizers and was significantly influenced by the temperature and humidity conditions. The second most significant cause of the strains is the irregular thickness of column spaces and uneven liquid crystal droplets in liquid crystal filling process. In order to reduce the strains, we modified the design of shipping tray and the manufacturing processes of LC filling and polarizer lamination, which led to the reduction of the panel bending from 1.54mm to 0.27mm, as shown in Fig. 1. In particular, the modification in the design of shipping tray made a significant improvement in the panel bending during shipping process. To reduce the external stress, the design of panel covering chassis was also altered.

Based on the results, the optimum designs and processes were applied to 27inch PLS monitor product, and we obtained a great improvement in the yields related to the relevent defects 27% to 1.2%, as shown in Fig. 2. The technologies can be used not only for solving the light leakage problem, but also for developing curved displays, wide screen display, wearable displays, window glass displays, and high-quality displays for medical or special usages.

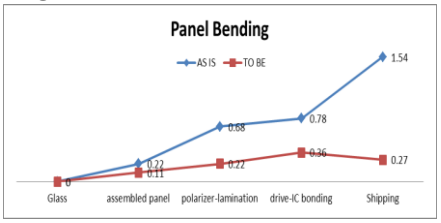

Fig. 1. Panel Bending of sub steps

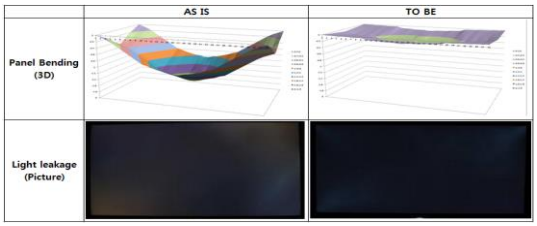

Fig. 2. Panel Bending(3D) and Light leakage(Picture)

References

1. K. H. Kim, K. H. Lee, S. B. Park, J. K. Song, S. N. Kim, and J. H. Souk, “Domain divided vertical alignment mode with optimized fringe field effect,” in Proc. 18th Int. Display Research Conf. (Kobe, Japan, Dec. 1998), pp. 383-386.
2. X. Zhu, Z. Ge, and S. T. Wu, “Analytical solutions for uniaxial-film-compensated wide-view liquid crystal displays,” J. of Display Technology 2, 2-20 (2006).
3. P. Yeh and C. Gu, Optics of Liquid Crystal Displays (Wiley,Hoboken, NJ, USA, 2010).
4. Y. Utsumi, S. Takeda, I. Hiyama, Y. Tomioka, M. Ishii,and K. Ono, “Light leakage behaviors of homogeneously aligned liquid crystal layers placed between crossed polarizers,”Jpn. J. Appl. Phys. 47, 2144-2148 (2008).
5. T. Mizutani, T. Ikeda, K. Miyake, and N. Miyazaki, “Warpageanalysis of an LCD panel under thermo-mechanical and hygro-mechanical stress,” in Proc. EMAP 2007 (Daejeon,)