Viewing angle measurements on curved displays: measurements & simulations

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The fact that a display is no more flat induces new visual effects that must be studied specifically. In 2012, we have shown how to compute the changes in the display aspect when a display is curved along one direction [1]. This computation is based on viewing angle measurements made in flat configuration and geometrical considerations. Up to now most of the characterization studies of curved displays have been focused on the driving, bending and stability properties. Few studies have been devoted to the optical performances even if the emissive characteristics of a curved display are clearly affected by the radius of curvature, bending axis and bending direction. Viewing angle measurements have been performed on flexible reflective displays using ring illumination [2] and on OLED displays curved along cylindrical convex shape [3]. However, no systematic study has been made to define the limit of validity of this type of measurement in relation to the geometry of the display and the measurement instrument. The purpose of this paper is to fill this gap presenting a rigorous computation of the collection of a parallel beam emitted by a curved surface and the consequences in terms of intermixing of angles. Practical conditions to make reliable measurements on curved displays are deduced.

The paper will express the exact variation of reflective angles versus radius of curvature R and defocus H for a standard viewing angle system (goniometer or Fourier optics) and compared the simulations to real measurements made on large size curved TV and across flat or bended BEF film. One example of such comparison is reported in figure 1. For the flat measurement, the decrease of transmittance of the BEF film above 30° is due to the total reflection of the light on the tilted faces of the numerous prisms which cover this type of film (cf. fig 1.a). The curvature of the film around the vertical axis (R = 130mm, H = 8mm) induces a widening of the pattern along horizontal (cf. fig.1.b). Using the data obtain on the flat film we have simulated the transmittance angle pattern after curvature of the film taking into account the spot geometry and the effective spot surface. The result reported in fig.1.c shows that the simulation method is valid.

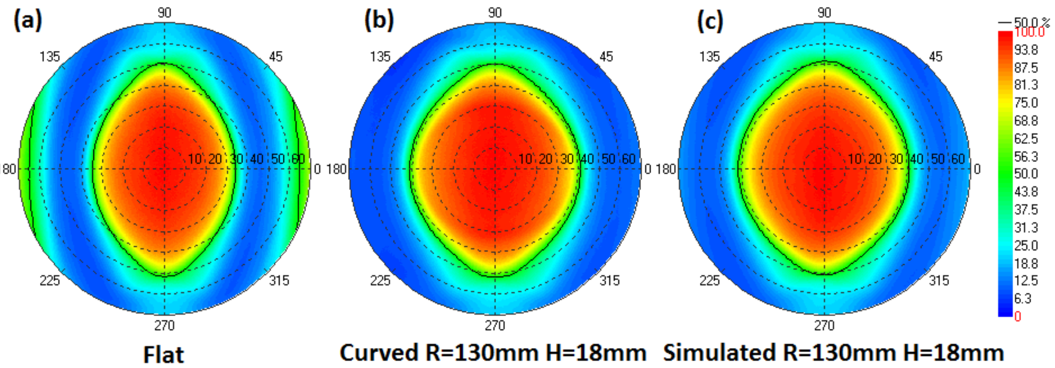

Fig. 1. Transmittance of BEF film : measurements for flat (a) and curved configuration (b) and simulation of curved configuration using flat measurement data (c): R =130mm, H=18mm

The limit of validity of viewing angle measurements on a curved display have been deduced. If the ratio spot size over radius of curvature of the display is below 0.5%, the measurement errors in the angles cannot exceed 1° for all the viewing angles and the accuracy of the measurements remains excellent.

References

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