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Pre-Standard

First edition
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Liquid crystal display devices –

Part 5-3: Liquid crystal display devices – Glass strength and reliability measurement method

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LIQUID CRYSTAL DISPLAY DEVICES –

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IEC-PAS 61747-5-3 has been processed by IEC technical committee 110: Flat panel display devices.

The text of this PAS is based on the following document:	This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document:
Draft PAS	**Report on voting**
110/85/NP	110/103/RVN

Following publication of this PAS, which is a pre-standard publication, the technical committee or subcommittee concerned will transform it into an International Standard.

This PAS shall remain valid for an initial maximum period of three years starting from 2007-05. The validity may be extended for a single three-year period, following which it shall be revised to become another type of normative document or shall be withdrawn.

INTRODUCTION

This PAS is devoted to the mechanical reliability of liquid crystal display (LCD) devices. This PAS is restricted to transmissive or reflective LCD modules using either segment, passive or active matrix and achromatic or colour-type LCDs that are equipped with their own integrated source of illumination or without their own source of illumination. Analysis and testing are performed on LCD module component glass as well as finished on LCD modules. Statistics of the mechanical strength of the modules are determined, allowing a prediction of module failure probability at a given stress level, or, for a given probability of failure, the maximum recommended safe loading stress for the module.

LIQUID CRYSTAL DISPLAY DEVICES –

Part 5-3: Liquid crystal display devices – Glass strength and reliability measurement method

1 Scope and object

This PAS applies to commercially available liquid crystal displays (LCDs). This PAS applies to all LCD types, including transmissive, reflective or transflective LCD modules using either segment, passive or active matrix and achromatic or colour-type LCDs that are equipped with their own integrated source of illumination or without their own source of illumination.

The object of this PAS is to establish uniform requirements for accurate and reliable measurements of the following LCD parameters, as defined herein:

a) quasistatic strength;

b) quasistatic fatigue.

The methods described in this PAS apply to all sizes, small and large, of LCDs.

Methods for measuring the fatigue constant are described in this PAS and are taken from the referenced literature [13-20]. The primary results are formulae for estimated allowable stress for the specified lifetime or estimated failure rate for the specified stress level. By way of an example, limited data for strength and fatigue behaviour of LCD glass are included in an informative annex to this PAS. Similarly, limited data for the static strength of LCD modules is also included and compared with that of parent glass

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61747-5, *Liquid crystal display devices – Part 5: Environmental, endurance and mechanical test methods*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
strength
stress at which a sample fails for a given loading condition

3.2
LCD surface strength
biaxial strength wherein surface flaws with different orientations are subjected to uniform tension during measurement [1-4]

3.3
LCD edge strength
uniaxial strength wherein edge flaws are subjected to tension during measurement [5-8]

3.4
LCD (mechanical) reliability
Reliability expressed as either an estimated allowable stress which the LCDs can sustain for a specified period of time or as an estimated failure rate at a specified stress level. For quantifying the reliability of LCDs, both approaches use the power law for slow crack growth and require the knowledge of the fatigue constant for the parent glass employed in the LCD displays [9-12]

3.5
parent glass
sheet glass used as raw material for manufacturing of LCD panels and modules

4 Abbreviated terms

For the purposes of this document, the following abbreviations apply.

FC	filled cell
FEA	finite element analysis
FPD	flat panel display
LCD	liquid crystal display
MC	mirror constant
MR	mirror radius
ROR	ring on ring
SCSC	stress corrosion susceptibility constant
VBT	vertical bend test

5 Apparatus

The parameters in the following figures are used in the stress formulae of Clause 8. The dimensions are:

a) load (force): Newtons (N);
b) dimensions: millimeters (mm);
c) stress: MegaPascals (MPa).

The standard atmospheric conditions given in IEC 61747-5, 1.4.3, shall apply, except that the relative humidity shall be in excess of 95 % (vapour) unless otherwise specifically agreed between the customer and the supplier.

5.1 Method A: Quasistatic biaxial strength

The quasistatic biaxial strength of parent glass is measured in the ring-on-ring (ROR) fixture shown in Figure 1. The dimensions of load and support rings are selected so as to minimize large deflection and the associated membrane stress, especially for ultra-thin glass, although the effect of such non-linearities on strength can be quantified using finite element analysis (FEA) [21-24]. All ring surfaces in contact with the test specimens should be rounded off, with radii of 2× to 3× the thickness of the glass specimen. In general, certain trade-offs are necessary in designing the test specimen and the ROR fixture because the key object is to measure the quasistatic strength of as large a test area as possible without introducing large non-linearities. Alternatively, a large sample quantity is required to obtain the strength distribution representative of full-size module. Since the strength of glass surface is primarily dictated by the quality of that surface, i.e., surface defects, it is imperative to measure the biaxial strength of those surfaces that have been exposed to handling and processing damage during the fabrication of LCD devices. Such data are then a good representation of LCD module strength.

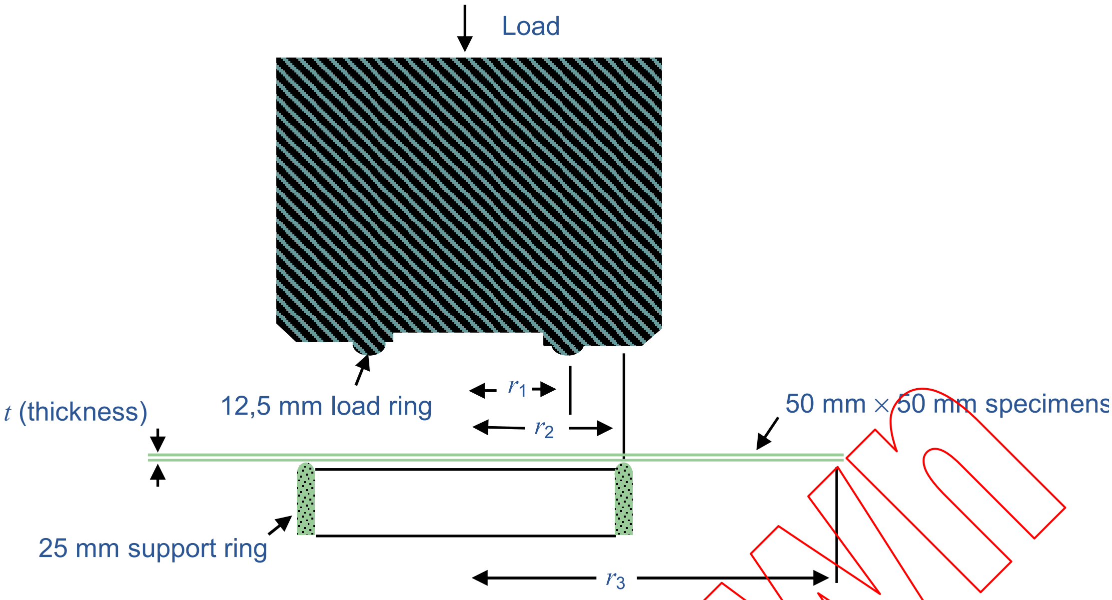

Figure 1 – Schematic of ROR test fixture for measuring biaxial strength of parent glass

For square specimens, the specimen radius, r_3, is the average of the inscribed and circumscribed circles.

5.2 Method B: Quasistatic edge strength (parent glass)

The quasistatic strength of the edges of parent glass is measured in the VBT fixture shown in Figure 2. The dimensions of the glass specimen and the test fixture are so chosen as to minimize buckling of the top edge which is in compression during the test because the load is applied from the top. As in the case of surface strength, it is equally imperative that the edges of glass specimens should have been exposed to handling and processing damage during the fabrication of LCD devices. In addition, the glass specimen should be large enough to represent the full-size module.

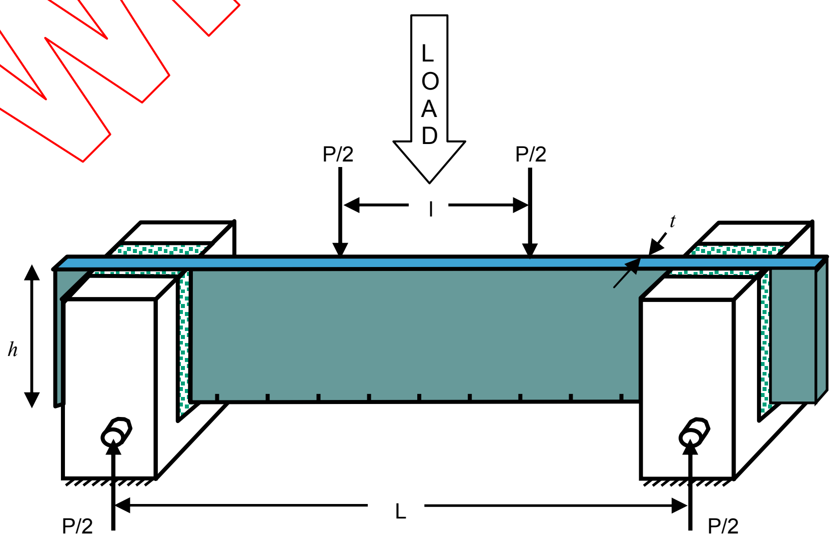

Figure 2 – Vertical bend test fixture for measuring the edge strength of parent glass

5.3 Method C: Quasistatic strength (module)

The quasistatic strength of the full-size module is measured by supporting it on the mounting points and loading it at the centre, as shown in Figure 3. The loading point of the test fixture is rounded and may be padded to avoid inducing additional flaws on the glass surface. Several modules are tested in this manner to obtain a statistically significant strength distribution representative of surface damage induced by the handling, processing and fabrication of the LCD module. These data are also useful for estimating the module strength at orders of magnitude of lower failure probabilities. The same apparatus may also be used for loading the LCD module off centre and obtaining its strength at different locations.

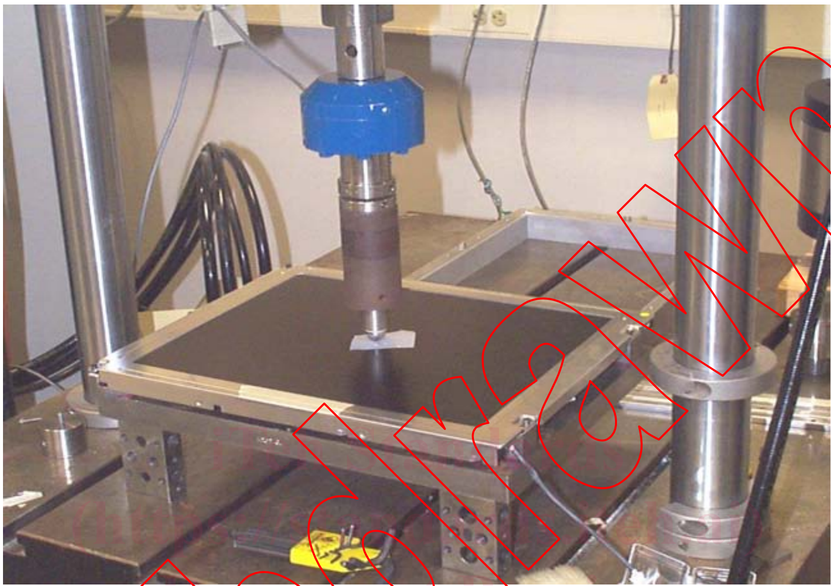

Figure 3a

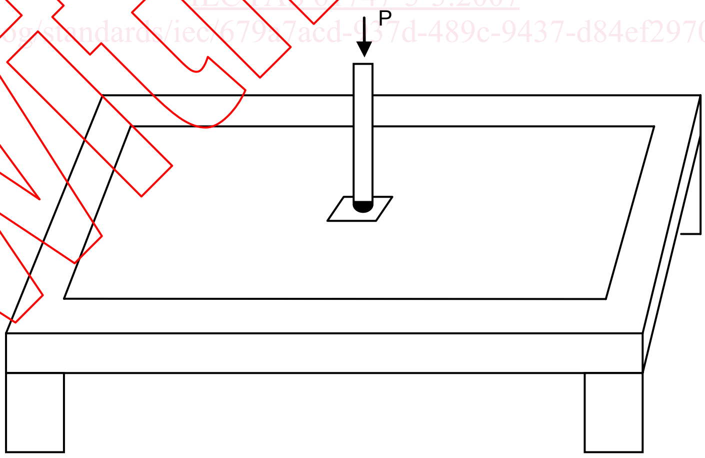

Figure 3b

Figure 3 – Schematic of strength measurement for full-size LCD module

5.4 Method D: Fatigue constant

The fatigue constant of parent glass is obtained by measuring its biaxial strength at four, or more, different stress rates, each successive rate being one order of magnitude lower, using the ROR fixture shown in Figure 1. A sample quantity of at least 25 specimens shall be used at each of the stress rates to obtain a reliable value of fatigue constant. The specimens used