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C—4—6 "Active" sintered ZnO substrates for liquid crystal displays

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The absence of a sharp non-linear optical response versus applied voltage in most liquid crystals is the major limitation to the realization of matrix addressed flat display panels with high multiplexing capabilities. Several addressing schemes using such a threshold provided by an additional non-linear control device at each picture element have been proposed. One possible device is the metal oxide varistor.

Matrix addressing of cholesteric-nematic liquid crystals with non-linear current-voltage characteristics of ZnO doped ceramic substrates, developed for solid state surge arresters, has been first demonstrated by Castelberry (1).

An array of twin electrodes evaporated on the polished ZnO substrate with intrinsic varistor behavior, gives simply the control devices matrix; the threshold voltage being defined by the electrode spacing.

The varistor effect discovered in polycrystalline zinc oxide by Matsuoka (2) has several advantages : symmetrical characteristics allowing AC excitation of the liquid crystal cells, threshold voltage with strongly non-linear I-V characteristics, remarkable low leakage current at low voltage and potential low cost fabrication by ceramic technologies. Statistical variation of breakdown voltage among devices on the same substrate, their high capacitance and the operating voltage levels between 60 and 100 volts are the major drawbacks.

Substrates of 100 cm^2 area and 1mm thickness have been prepared with homogeneous density and microstructure over the whole surface.

Mean grain size has been controlled by composition and sintering parameters and two relations have been established : - a linear relation between breakdown voltage and surface interelectrode spacing - a non-linear behavior between capacitance and interelectrode distance.

On a carefully controlled quality substrate of 5μm mean grain size the statistical distribution of breakdown voltages over the whole surface has been recorded for different interelectrode spacings : from 100 μm to 400 μm i.e. breakdown voltages between 45 V and 200 V. Application of these performances to intermediate sized interaction flat liquid cristal displays is discussed.

(1) D.Castelberry, L.Levinson
1980 Biennal Display Research Conference, p.198

(2) M.Matsuoka, T.Masumaya, Y.Iida
"Non-Ohmic Properties of zinc oxide ceramics"
Japanese J. of Appl. Phys., vol.10, n°6, p.736, (1971)