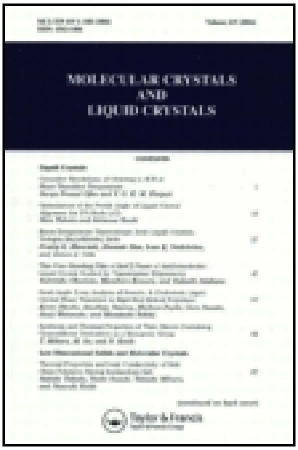

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High Multiplexed MIM-Addressed LCD

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HIGH MULTIPLEXED MIM-ADDRESSED LCD

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Abstract The results of the experimental study of MIM-diode matrixes for high multiplexed LCD's active addressing are discussed. Various constructions and technologies of MIM-diodes have been studied and optimal technological routes have been selected. Using these diodes the high-resolution matri- es were fabricated and the high-contrast reflective LCD's operating at duty ratio of 1/500 were achieved.

INTRODUCTION

Active-matrix addressing liquid crystal displays (AM LCD's) are widely used now. Thin film electronic device is used at each picture cell to control pixel intensity. By making pixel small-near the limit of what an human eye can see (about 150um)-and by providing pixels of the three primary colors in"triads", color pictures of high quality can be realized.

AM LCD's technology is the only one being seriously funded for flat screen video applications. It has demonstrated the necessary switching speed, the potential for low cost manufacture and the ability to provide full color pictures at video rates. Probably the most important issue is to guarantee the stability, reproducibility and simplicity of matrices fabrication process and ensure their minimum defectness. From this point of view the MIM(metal-insulator-metal)-diode matrices meet the listed requirements the most fully.[1]

MIM-DIODES FABRICATION PROCESS

The authors have examined some constructive-technological versions of MIM-diodes with the structure of Ta-

Ta_2O_5-Cr(ITO), which have stable and reproducible characteristics. In order to reduce the stray capacitance of MIM-diodes they were formed on the lateral surface of tantalum buses.[2] The minimum feature size in this case did not exceed 10 µm and the layers alignment accuracy-2 µm which allowed to use a standart photolithographic equipment.

The fabrication process of MIM-diodes included sequence of the following steps: a tantalum film of 350 nm thick deposited on a glass substrate with buffer insulator layer was anodized in 0.1% a ueous solution of citric acid to form the upper passivating insulator of 350-400 nm thick. Then the address bus pattern photolithography was used followed by plasma-chemical etching of Ta_2O_5 and Ta in fluorine-containing plasma up to the buffer layer. The conditions of the etch process were chosen such that to provide the necessary profile of tantalum buses. After that, the tantalum was oxidized in the same electrolite and the transparent electrodes from ITO of 100 nm thick were formed. In the final step, a chromium film was deposited and the upper electrodes of MIM-diodes were patterned.

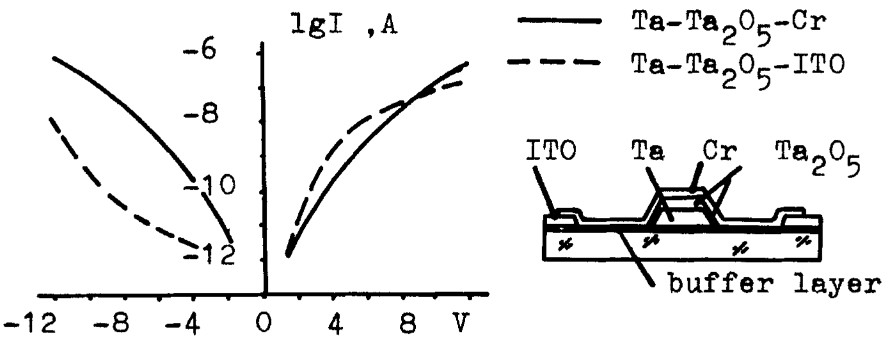

FIGURE 1 The MIM-diodes structure and their typical I-V characteristics.

The investigation carried out has shown that Ta_2O_5 as an upper passivating insulator is advisable if the area of the pixels is more then 0.05 mm^2.At smaller sizes the presence of the stray capacitance,which is due to the overlapping of the chromium electrode and tantalum bus,should be taken into account.In connection with this,the alternative versions of MIM-diodes constructions have been developed and studied,where polyimide, Al_2O_3 or SiO_2 films are used as an passivating insulator.It has been found that the most acceptable is the former version.However,the difficulties arising with providing the uniformity of the polyimide films on the glass plates of large sizes,limit their application in the generation of the full-size,high-resolution LCD's.

In forming the upper electrode of MIM-diodes from ITO instead of Cr,the number of photolithographic steps can be limited to two,but the symmetrical I-V characteristics of such diodes cannot be obtained.(see fig 1).

The studied MIM-diodes,which area was 15x0,2 μm^2 and the thickness of Ta_2O_5-45 nm,provided the off-current less than 1 pA(V=2V),which was the measurable limit,and the on-current-1 μA(V=12V).The on-off ratio of 10^6 was large enough for AM LCD's use.

MIM-DIODE MATRIXES

To ensure the constancy of MIM-diodes electrical parameters,special topology providing the self-alignment have been designed.Figure 2 is a photograph of the 320x 200 matrixes fragment.The pixels pitch is 250x180 μm, both data and scanning lines widths are 20 μm.The aperture ratio of each pixel picture cell,i.e.the ratio of the effective area to total cell area,is more than 50%. To increase the fabrication yield of matrixes special topology providing redundancy have been designed.Each pixel in this case is addressed by four MIM-diodes simultaneously. Defective diodes may be cut off by laser beam during the repair or even after AM LCD assembling. The presence of double scanning lines ensure the supplementary redundancy.

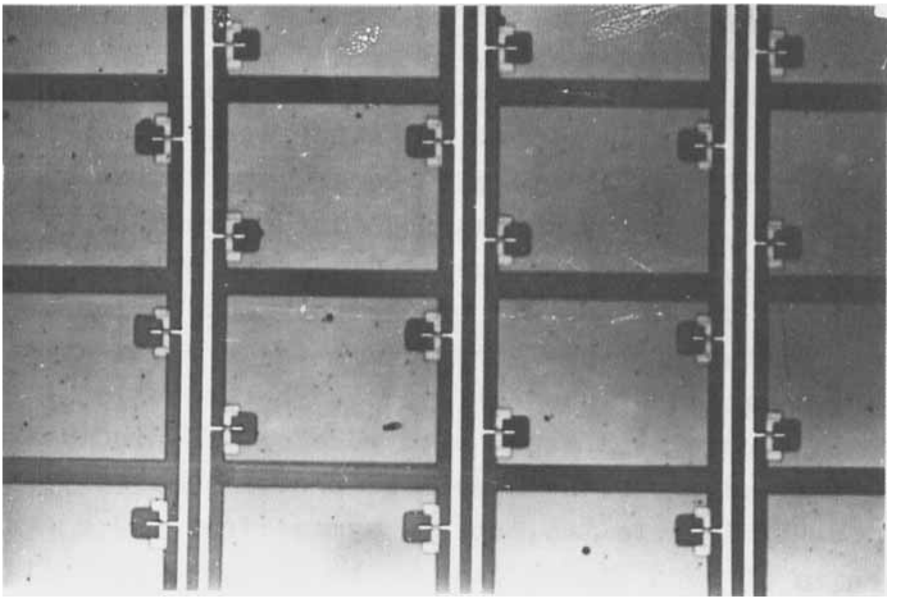

FIGURE 2 The fragment of the MIM-diode matrixes.

AM LCD ASSEMBLING

Using the described above matrixes the reflective type AM LCD's have been assembled. The 6 μm-liquid crystal layer was the twisted nematic type. The aligning layer films were coated on the AM-substrate at the temperature of about 200°C. After the liquid crystal was sealed, a pair of polarizers and reflective film were attached. An outer driver circuit was connected by an anisotropic conductive elastomer on the terminal electrodes with the pitch of 250x180 μm.

A line-at-a-time addressing scheme with a duty ratio of 1/500 was used. The scanning pulses with amplitudes of 18V and data pulses with amplitudes of ±2V were applied.The frame frequency was 50 Hz.Under these conditions a high contrast ratio of about 10:1 was achieved.Table 1 summarizes the main characteristics of the assembled AM LCD's.

TABLE 1 Main characteristics of AM LCD's.

Characteristics	Value
Display mode	twist nematic
Number of pixels	320x200
Pixel pitch	180x250 μm
Duty ratio	1/500
Frame freguency	50 Hz
Driving voltages	18 V(scanning lines)
	±2 V(data lines)
Contrast ratio	10:1
Viewing angle	±65°

As can be seen from the table 1 the designed version of AM LCD provides the high informative capacity,needed for portable PC's and TV sets.

CONCLUSION

Authors have designed the high guality AM LCD addressed by MIM-diode matrix ,which can be used for displaying symbolic,graphic and dynamic information,full color picture included.Scaling up laboratory processes to production levels is the next challenge.

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