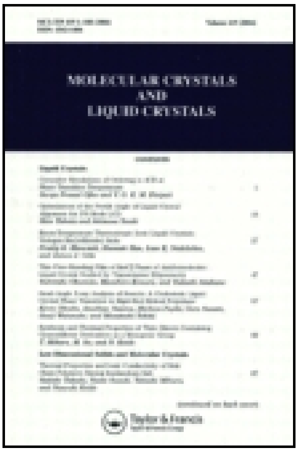

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6″ MIM Addressed Color TN LCD for Laptop Computer

A. Smirnov [a] , I. Ladocha [b] , V. Lebedev [b] , O. Moiseeva [a] , V. Osika [b] , A. Usenok [a] & V. Vysotsky [a]

[a] Radioengineering Institute, Minsk, USSR

[b] NPO "Integral", Minsk, USSR

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6" MIM ADDRESSED COLOR TN LCD FOR LAPTOP COMPUTER

A.SMIRNOV, I.LADOCHA*, V.LEBEDEV*, O.MOISEEVA, V.OSIKA*. A.USENOK, V.VYSOTSKY
*Radioengineering Institute, Minsk, USSR
NPO "Integral", Minsk, USSR
(*Received March 14, 1991*)

Abstract 640x400 metal-insulator-metal (MIM) addressed color TN LCD with diagonal of 6" has been developed. Special topology of MIM active matrix (AM) and simple technological process of its fabrication have allowed to produce low-cost, high quality displays using standard photolithographic equipment with 2 mkm alignment accuracy and 5 mkm minimum feature size. Optimization of the key technological steps has been done.

Keywords: color TN LCD, laptop computer, active matrix, MIM diode

INTRODUCTION

In conventional AM LCD applications such as laptop personal computers (PC's) and portable TV's, where weight, cost and battery operation are important, the evolution toward larger size, higher resolution and improved contrast continues. Response times and full color are also becoming more important because window-type software increasingly demands mouse interfacing. Recently MIM addressed LCD's have become one of the promising AM technology [1,2]. This technology has advanced from a research subject towards a commercial product It seems that full color graphic MIM addressed LCD's can be a serious challenge for TFT LCD's in the field of laptop PC's [3]. So the main goal of this work was to develop a simple and cheap technological process suitable for mass production of low-cost color MIM addressed LCD's.

ACTIVE MATRIX TOPOLOGY

640x400 matrix of MIM diodes with the lateral structure of Ta-Ta_2O_5-Cr has been developed. The pitch of pixels was 200 mkm on horizontal and 240 mkm on vertical. To reduce the influence of stray capacitances which are due to the overlapping of the chromium upper electrodes and tantalum buses special topology of MIM diodes has been designed. It provides very high degree of diodes electrical parameters uniformity over large area due to self-alignment, the possibility of AM redundancy and repairing.

Fig.1 demonstrates a view of AM fragment topology. It can be seen that a pixel is addressed by two similar MIM diodes simultaneously. Each diode includes three lateral Ta-Ta_2O_5-Cr structures. In such a case the ratio of Cmim to Cstr is increased and it is maximum when all dimensions of lateral are equal.

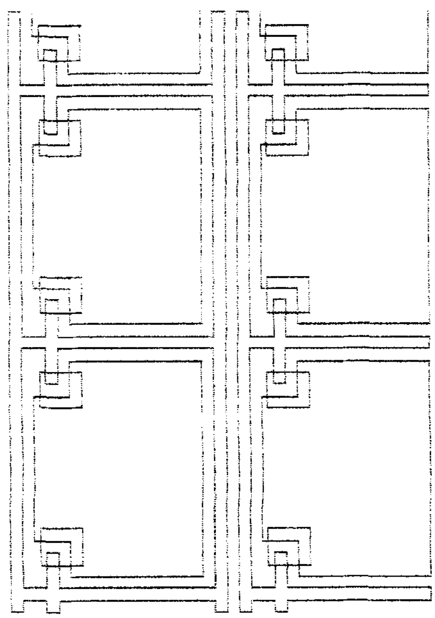

FIGURE 1 Fragment of AM topology

ACTIVE MATRIX TECHNOLOGY

The sequence of fabrication steps was as follows [4]:

- Magnetron sputtering of 0.35-0.4 mkm thick Ta film on a glass substrate coated with thermally grown 0.1mkm tantalum oxide film (the buffer layer);
- Anodization of Ta in 0.01% aqueous solution of citric acid to form the upper Ta_2O_5 passivating layer of 0.35-0.4 mkm thick;
- Photolithography puttering of the Ta-buses;

- Plasma-chemical etching (PCE) of double Ta_2O_5-Ta structure up to buffer layer;
- Anodization of Ta-lateral surfaces in 0.01% aqueous solution of citric acid at Van=32 V to provide the oxide thickness 55 nm;
- Formation of Cr and ITO transparent electrodes.

Our technological experience confirms the conclusion that the process of plasma-chemical etching of Ta_2O_5 - Ta double

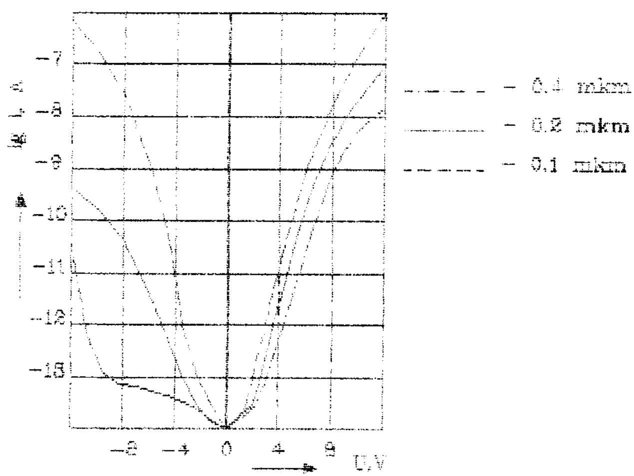

FIGURE 2 Influence of the „overetching" on MIM diodes I-V characteristics

layer structure is one of the most important steps in MIM technology. It must provide high and comparable etch rates of Ta and Ta_2O_5, uniformity of etch rate across the substrate, reproductibility of the process, "polishing" etching. control of the lateral surfaces profile.

The etch tool of the type 08 PCO-100T-005, realizing a method of reactive-ion etching, has been used. The selection of gases mixtures depends upon the etch requirements. We have investigated fluorine containing gases and their mixtures with oxygen. Some important parameters of the process were carefully controlled: RF-power, etch rates, partial pressures of components, angle of etch profile (from REM-analyses).

The investigations carried out have shown, that it was impossible to improve etch rates and to get comparable rates for Ta and Ta_2O_5 using SF_6, CF_4 or C_3F_8. The good results were observed with SF_6- plasma, but the etch rate for Ta was about twice higher than for Ta_2O_5, leading to negative profile formation. The influence of such a "overetching" on MIM diodes I-V characteristics is shown in fig 2.

It possible to increase the etch rate of Ta_2O_5 adding oxygen to mentioned above gases. The dependencies of etch rates for these mixtures from oxygen content are shown in fig.3. As can be seen the best results were observed with

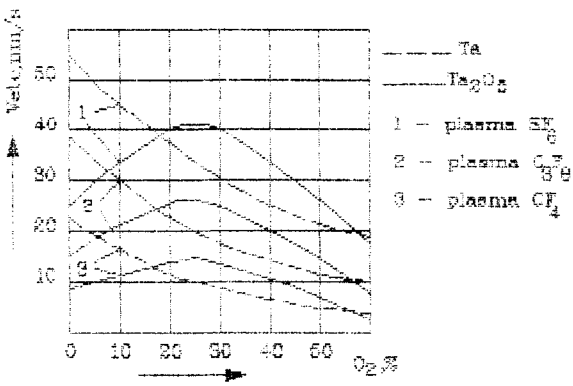

FIGURE 3 Etch rates for Ta and Ta_2O_5 oxygen content

C_3F_8 (80%)+O_2 (20%) mixtures, which provided not only equal etch rates for Ta and Ta_2O_5, but the optimal profile and polishing etching also. We should bear in mind that some problems with photoresist mask stability and its removal after PCE process were existing. So double layer mask, including 1 mkm of photoresist and 0.15 mkm of vanadium film, should be used.

Annealing of Ta - Ta_2O_5 structure is usually done before evaporation of Cr and considerably influences the stability, reproductibility and symmetry of MIM diodes I-V characteristics. We have investigated the influence of temperature, annealing time on the conductivity (fig.4) and I-V characteristics of MIM-diodes (fig.5). We have found, that optimal annealing process takes place in nitrogen atmosphere at Tan = 300°C, t = 90 min.

CONCLUSION

Projection type of 640x400 MIM addressed color LCD's with 6" diagonal and gap of the 8 mkm have been assembled. The alignment layers were coated on the substrates at T=160 °C. After the 1289 type liquid crystal was sealed,a pair of polarizers (90% efficiency) were attached.The line-at-a-time addressing scheme with a duty ratio of 1:400 and frame frequency of 50Hz was used.The ±18V scanning pulses and ±2V data pulses were applied.A contrast ratio as high as 20:1 and wide wiewing angles were achieved.

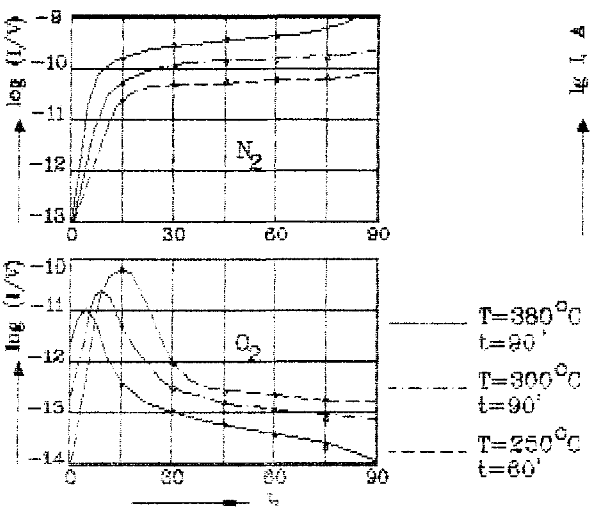

FIGURE 4 Influence of the annealing on MIM's conductivity

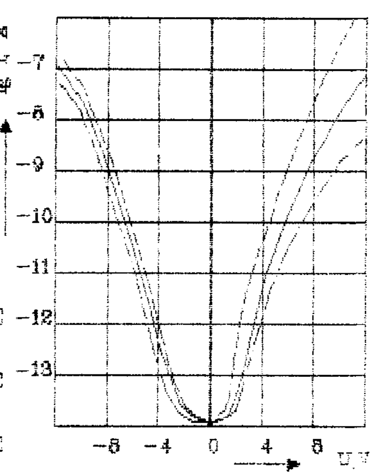

FIGURE 5 Influence of the annealing on I-V characteristics

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