MEASURE UNIT FOR NOISE STUDY IN ORGANIC FET

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ABSTRACT

Abstract. In general organic field effect transistors (FETs) are thin film transistors of a MISFET (metal-insulator-semiconductor) geometry(see Fig. 1) The transistor may include an inorganic substrate (which may also serve as Gate electrode), insulator or electrodes[3]. As there has not been many articles published yet related to the area of noise analysis of organic semiconductors, following information are crucial basement for the future noise investigation and provide knowledge to prepare and set up the low noise unit for organic structure measurement, which can be used for either organic unipole device or organic dipole device with one common electrode characterization.

1. INTRODUCTION

The analysis mentioned below will uncover the whole view to OFET noise, which could describes causes of individual components and a behaviour of the major noise sources. As the process of the charge transport within the the organic semiconductors is known [7], there is a need to confirm and more specify the teory of that process. Investigating the significance of the noise sources can brings us to determination of the importance of transport processes in organic semiconductors.

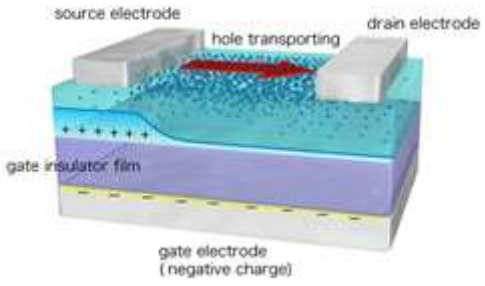

FIGURE 1: Structure of ambipolar OFET[6]

2. REQUIREMENT ANALYSIS

It is appropriate to recognize the fundamental difference between the noise measurement in semiconductors, based on monocrystal or amorphous silicon, and the semiconductors based on organic materials. Organic semiconductors have a much lower rate of charge carriers drift. The Pentacene as the most widely used material in this time for the semi conducting purpose has several times higher static resistance, therefore optimal currents for OFET are in the range of tens micro amperes. There must be an adaptation to this known property to avoid a useful noise masking by the external environmental disturbances. The situation can become worse when analyzed samples of OFETs are not packaged and have not any pins for connection to circuit. There is a need to dispose a contacting station which of course has to have very long shield connection wires that makes disturbances absorption higher in comparison with pins of packaged OFET. It is necessary to adapt the design of the measurement unit to this situation.

3. UNIT REALIZATION

The unit consists of the main shielded box with sensitive parts of measure workspace included. The main shielded box has an aim to decrease the environment distortion influence and the interferences from several sources. The contacting station closed into the main box for the reason of unpackaged samples usage, not supplied by the pins. The contacting station consists of a movable base on which are placed samples and the support ramp with ability to mount probes. The samples, placed on the movable base, are attached by the vacuum provided by an air pump, which is located outside the main box. The insulating pad is used to substantiate the sample and to isolate the Gate electrode from large are contact represented by the movable base. The support ramp is fitted by three probes with tips, suitable for connection of the sample. There is the very important point of construction as the probes end should has larger contact area the usual, the sample surface must be protected from scratching by the probe contact due to the metal surface of the sample used is very sensitive to abrasion.

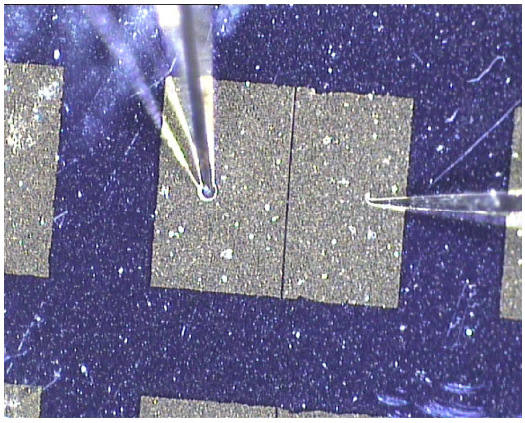

FIGURE 2. : The sample of OFET in microscope

The source and the drain electrodes are directly connected via probes, the probe touches the insulating washer, which is the top metal coated, the gate electrode is connected through this washer. Outputs of probes are connected to a circuit shielded box. The source voltages Vg and Vds are connected to this box as well. Both voltages are provided by the double output source controlled via GPIB interface from the PC. The researched noise will be studied by passing current though organic material, a current Id, which is brought to an amplifier with AC input coupling, is amplified. The amplifier is equipped with High-band and Low-band filters. Therefore there is an ability to reduce the measured spectrum to the desired width. Amplifier output is connected to an oscilloscope, its output to the computer for easy viewing of results and their processing.

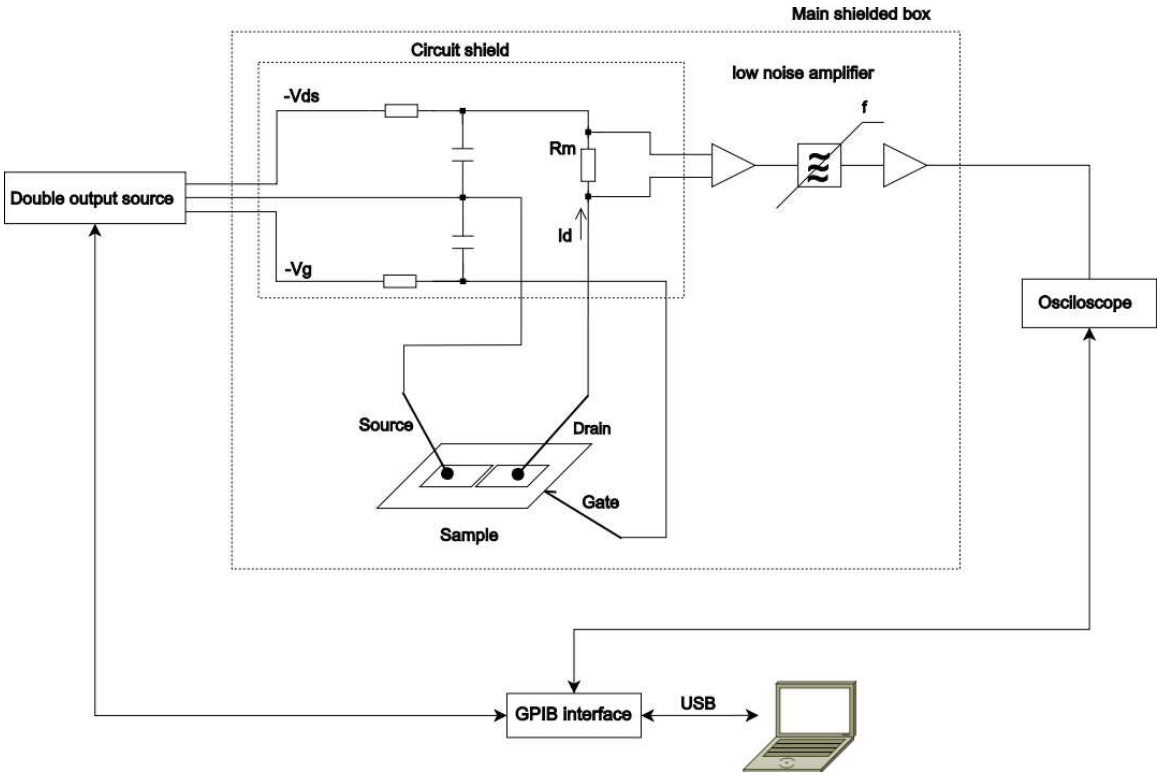

FIGURE 3. Workspace schema

Choosing of the value of Rx is must carried out with respect to the peripheral conditions. The transistor should work in the middle of the VA characteristic, while the resistance of Rx has an impact on the adaptation of the noise source of their conductivity transfer to the amplifier. If it were not selected correctly, the transistor would not work in optimal mode, or the signal transport proportions do not allow the transfer of useful signal to the amplifier by the background enhancement.

FIGURE 4. : View on completed unit without main shielded box

4. CHARACTERISTIC ASSUMPTION VERIFICATION

For the purpose of quality verification and suitability of the unit adoption the measurement of the frequency spectrum by passing a current sample in comparison with the spectrum measured without the presence of the current sample is used. It can be used as an equivalent with comparison of time courses of current noise at the same two operating conditions. If the design is properly implemented, the useful noise can be wholly separated from the background noise, i.e. noise is not masked by useful one.

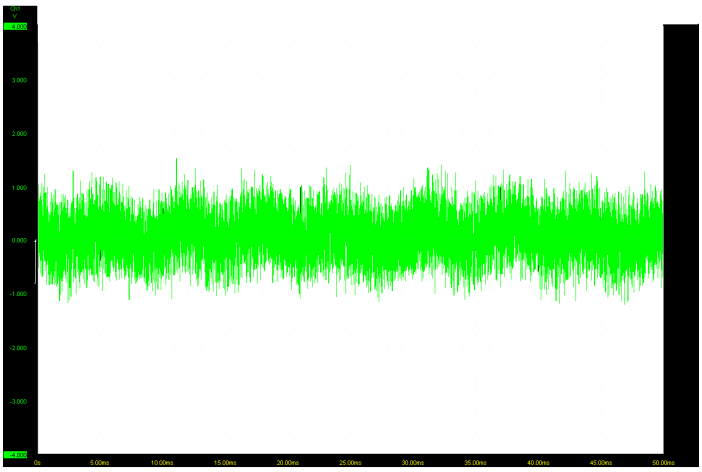

FIGURE 1. Background noise

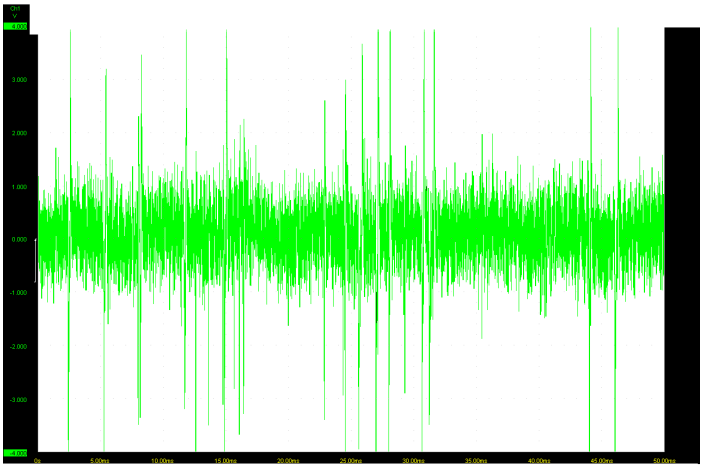

FIGURE 6. Valuable noise with background noise

The experimental measurement must confirm the design and suitability of the chosen structure of the unit. Since there have not been such articles published that can elucidate the total noise spectral density, it is not able precisely decide of the concept value. For this the purpose samples of N-OFET transistors with Pentacene ambipolar structured have been used. One of the many suitability indicators is the useful signal distance from the background noise. This can be easily determined from the view of the output signal. The signal

for Id is equal to 0A is in the figure 5. The optimal value of Id is chosen form the VA characteristic as a mean value. Figure 6 shows the output signal when this current flows through the sample. The S/N (the distance from the background noise) method result is higher than 3dB that is a critical value for any measurement.

5. CONCLUSION

It has been analyzed and prepared the unit for noise study of OFET, according to the theoretical considerations, for the measuring the noise within organic semiconductors, as it is now not very well known area or no much articles has been published. This is the predecessor for the analysis behavior, time dependence, spectrum of noise, determination of the physical essence of individual noise sources and their comparison, depending on the size of their component influences to the overall noise behavior. Based on knowledge of properties of organic semiconductors as materials in the low conductance it was necessary to pay attention mainly to the shielding degree of outside interference influencing the course of measurement. Suitability of design concepts and the accuracy of implementation was verified by measuring the N-OFET samples. The time behavior of the current within the organic semiconductor - pentacene as a FET channel - has been recorded and the S/N ratio has been determined. The measurement results confirmed the correctness of design work and the opportunity to study noise.

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