

The Electronic Properties of Film Materials Based on Fe and Pt or Ge

Vlasenko O.V., Assistant; Poduremne D.V., PhD Student;
Odnodvoret L.V., Associate Professor

Sumy State University, Department of Applied Physics, Sumy

On the basis of thin films in microelectronics made the following elements of integrated circuits (IC): film resistors; electrodes (electrode film capacitors, spiral inductors busducts, installation guides, closures MIS – transistors) contact paths and platforms; auxiliary elements. Electrical connection of metals and semiconductors with metallic conductors is performed using layered condensation and formation of ohmic contacts not rectifier, the quality of which is largely dependent parameters and characteristics of microelectronic devices, their reliability and durability. The metal / semiconductor (Me / Sem) can be rectifying (if potential barrier between the metal and semiconductor tunnel-opaque) or ohmic (potential barrier if it's missing or tunnel-transparent to electrons).

Formation of single- and two-layer films based on metals (Fe and Pt) and semiconductor (Ge) was carried out by thermal evaporation by layering condensation. Layered film condensation and annealing systems carried out by thermoresistive at glass ceramic substrate ($T_s \cong 300$ K) and were annealed at $T_a \cong 800$ K (Me / Me) and 1070 K (Me / Sem) for three cycles «heating \leftrightarrow cooling». The crystal structure and phase composition of the samples was investigated methods of electron microscopy (TEM-125K).

Measurement of current-voltage characteristics (CVC) film materials was conducted using circuit technology based NI LabVIEW, which has the following parameters: operating voltage range of the $\Delta U = -20$ V ... + 20 V; supply voltage 220 V; protection from external factors (magnetic and electric fields, humidity); temperature range: $\Delta T = +5$... + 40° C; possibility of constructing experimental dependencies in automatic mode; research samples with the value of resistance from 10 Ohm to 10 kOhm.

The device performs the functions analog input, analog output, digital input-output, audio input, output, power supply, digital multimeter (DMM) with USB and consists of a change in measurement accuracy and the power to produce, process and output, switch S1, alternating resistor R1 par value from 100 Ohm to 10 kOhm, four resistors R2-R5 different values, contacts

to measure resistance and two voltmeters. Block LM317 is used to stabilize voltage and current, resistors $R1 = 160 \text{ Ohm}$, $R2 = 520 \text{ Ohm}$, $R3 = 1,2 \text{ kOhm}$, $R4 = 8,9 \text{ kOhm}$ used to change the measurement accuracy.

Research CVC dual-layer films of Fe / metal and Fe / semiconductor indicate their linear and symmetrical (Fig. 1). Thus, for films Fe (5 nm) / Pt (5-15 nm) / S (S – substrate) while increasing the voltage from -10 to $+10 \text{ V}$ current increases linearly in the range of -30 to $+30 \text{ mA}$. The steepness of the CVC, which is $S = \Delta I / \Delta U = 4\text{-}6 \text{ mA} / \text{V}$, increases with increasing layer thickness Pt.

Properties film of Fe (30) / Ge (5-30) / S meet the requirements for ohmic contacts, namely at forward bias they provide major carriers injected into the semiconductor; the reverse bias – prevent injection of minority carriers in the semiconductor; have a minimum electrical resistance i linear symmetrical CVC, which slope $S = 0,025\text{-}1 \text{ mA} / \text{V}$ and increases with increasing layer thickness Ge.

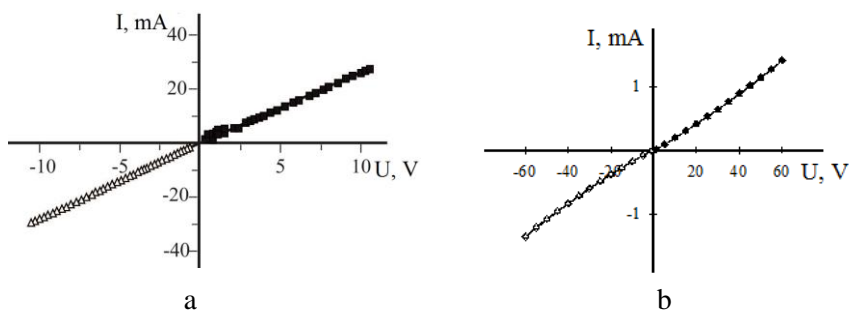


Figure 1 – CVC for annealed to 900 K films Fe (5) / Pt(5) / S (a) and Fe (30) / Ge(25) / S (b)

The nature of the research CVC films associated with the processes of solid phase synthesis in samples after annealing: streamlining processes in materials based Fe and Pt and the formation of magnetic phases germanides FeGe_x systems based on Fe and Ge.

The work performed under the state budget theme №52.20.01-01.15/17 Department of Applied Physics of Sumy State University (2015 – 2017 years).

Supervisor: Protsenko I.Yu., *Professor*