SYNTHESIZING MATERIALS BY LOW TEMPERATURE MOLECULAR BEAM EPITAXY METHOD

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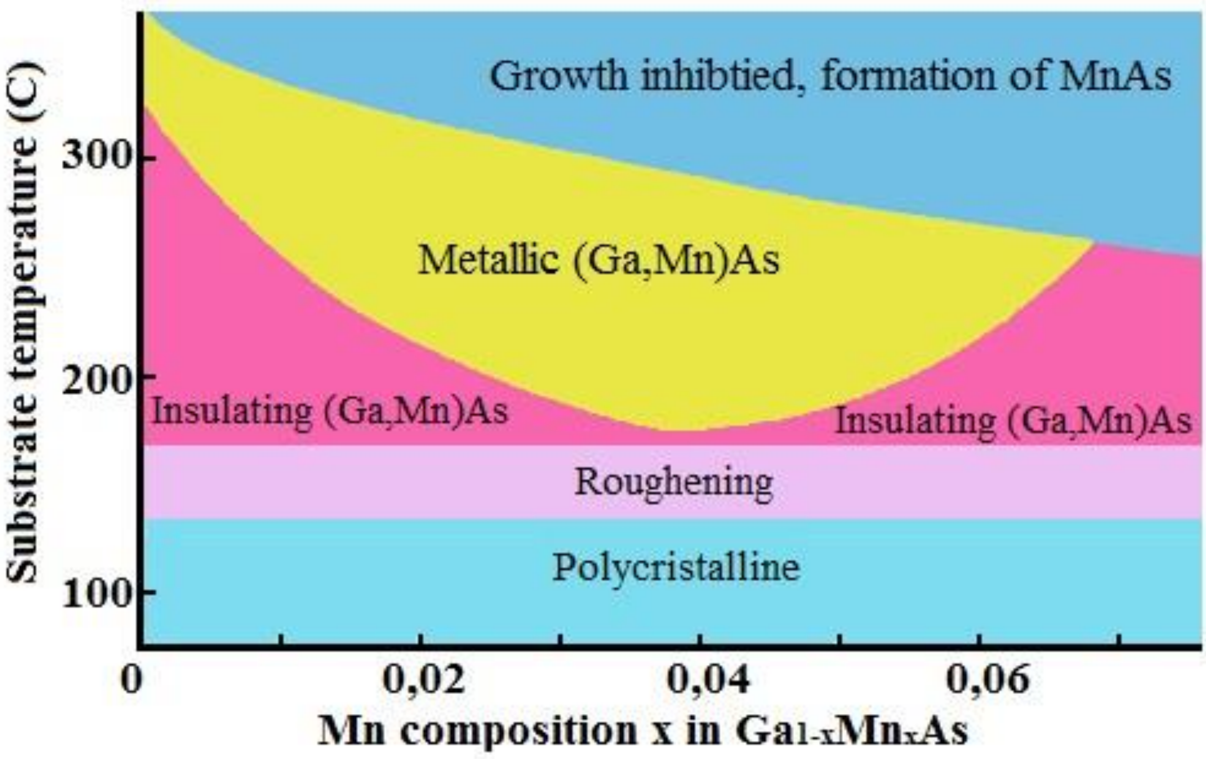
GaAs semiconductor matrix to create a magnetic ordering it is necessary to introduce ions of magnetic elements with a concentration much higher than the solubility limit of these elements in GaAs. Obtaining structures with an impurity concentration exceeding the solubility limit in a given semiconductor is possible only by non-equilibrium methods, which include low-temperature molecular beam epitaxy. However, even when using the LT MBE method, the possibility of obtaining homogeneous epitaxial GaMnAs layers is limited by a number of conditions such as the limiting Mn concentration and the temperature of the semiconductor substrate during epitaxy. The range of epitaxy modes allowed for growing homogeneous GaMnAs epitaxial layers is schematically shown in (Fig. 2. 1).The samples studied in this work were obtained by molecular beam epitaxy of GaMnAs on a semi-insulating GaAs substrate with a crystallographic orientation of (001).

A schematic diagram of the plant for growing epitaxial films is shown in

Figure 2.1 Dependence of the quality of GaMnAs epitaxial layers depends on the conditions of epitaxy**.**



Evaporation of materials deposited in ultrahigh vacuum on a substrate fixed on a manipulator with a heating device is carried out using effusion filters. cells (effusion – slow outflow of gases through small openings). The temperature of the vaporized substance was controlled by a thermocouple pressed against the crucible. The evaporator is mounted on a separate flange, on which there are 1 electrical leads for powering the heater and the thermocouple.

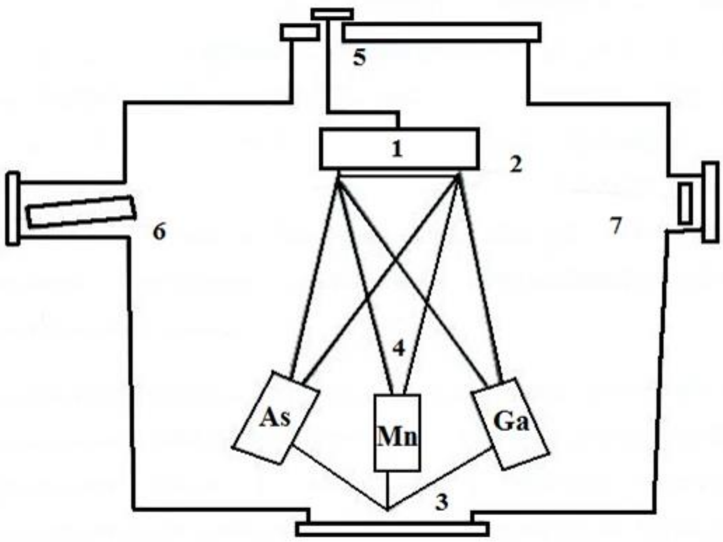


Fig. 2. 2 Schematic diagram of the installation of molecular beam epitaxy:
1-sample holder with heater; 2-sample; 3-effusion cells;
4-flaps; 5-manipulator; 6-DOBE electronic gun; 7-luminescent screen.

As a rule, in one growth chamber there are several (three) effusion systems cells, each of which contains the main components of films and materials of alloying impurities. To control the structure and morphology of the formed epitaxial structures, a reflected fast electron diffractometer is also located in the growth chamber. The diffractometer consists of an electron gun that generates a well-focused electron beam with an energy of 10-40 keV. The electron beam falls on the substrate at a very small angle to its plane, and the scattered electron waves give a diffraction pattern on the luminescent screen.

During the growing process , Ga, Mn, and As atomic fluxes from effusion wells were directed to the substrate located in a vacuum chamber and fixed in the holder. The flow rate was regulatedaby the temperature of the cells. The quality and uniformity of the growing epitaxial layer was controlled by the reflected fast electron diffraction method.

Before growing the GaMnAs epitaxial layer GaMnAs on a GaAs substrateGaAs , a high-temperature GaAs buffer layer was grown GaAs at a substrate temperature of 450-500° C. After that, the substrate temperature dropped to 250° C and the main

GaMnAs epitaxial layer was grown. Температура Effusion chamber temperature the Mn temperature in the growing process was 860° C. These conditions made it possible to obtain homogeneous epitaxial GaMnAs layers GaMnAs with a Mn impurity concentration of 0.78 at. % (the Mn impurity concentration in the studied samples was determined using electron probe microanalysis). The thickness of the studied samples was 250-300 nm.

For measurements, the test samples were cut into squares with dimensions of 0.5×0.5 cm. For magnetotransport measurements, indium contacts were deposited on the surface of the epitaxial layer.

X-ray diffraction studies also confirmed that the samples are homogeneous and do not contain inclusions of other phases. The concentration of the main charge carriers determined at room temperature from the measured Hall effect was $7\ 10^{-18}$ cm^{-3}.

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