Molecular layer epitaxy method. Formation of a monomolecular NTCDI layer on quartz substrates

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In recent years, considerable development gains organic electronics aimed at the development of a variety of electronic devices based on organic materials. When creating such devices, organic semiconductors are applied in the form of thin films. There are many methods for producing thin films: ink jet printing, centrifugation, plasma spraying, pyrolysis of aerosols, thermal evaporation, chemical vapor deposition (CVD), liquid phase epitaxy, etc.

Among the listed methods a special place is occupied by the molecular layer epitaxy (MLE) method, which is a kind of CVD and is found in the literature under different names (MLD, ALD, ML, etc.). This method of forming films for nanoelectronics is one of the most promising.

The method consists in successively alternating the operations of irreversible chemisorption (chemical reaction with the previous layer) of a certain precursor and cleaning the surface of an excess amount of a substance that is loosely bound by physical adsorption (both a precursor and reaction products).

Growth of monolayers was carried out on the previously developed unique installation of a molecular layer epitaxy. The working chamber of the installation contains three zones with independent heaters: inlet, reaction and outlet. The inlet zone of the reactor contains evaporators of organic precursors. In the second zone is the stage, the temperature of which is set independently of the temperature of the reactor walls. In the outlet region there is a baffle for outputting the carrier gas. The initial organic precursors are located in the sublimators and bubblers, which are connected to the reactor by gas lines. The gas flow through the system is set by the mass flow controllers and controlled by Baratron.

Quartz substrates were cleaned for 1 h in an ultrasonic bath in a hot (90 C) a piranha solution. The template layer was obtained on precleaned hydroxylated substrates by liquid-phase silanization reaction with 3 mmol (3-aminopropyl)trimethoxysilane. After the template layer was deposited the following film growth steps were conducted in the MLE reactor: The 1,8:4,5-naphthalenetetracarboxylic dianhydride precursor was vaporized at 200 C to react with the surface-bound amine; 1,6-diaminohexane precursor were vaporized at 40 C. Imidization in both steps was carried out at a substrate temperature of 295 C for 20 min at a total pressure of 20 mTorr. The reactor walls were independently heated to 330 C. There is the laminar flow through MLE reactor setup (Re is 250) Following the assembly of each monolayer, the reaction zone was cleaned by resublimation of unchanged precursors under an Ar flow for 10 min.

After the formation of the monolayer of the NTCDI the absorption spectrum of the samples was measured. The absorption spectrum was measured with the AvaSpec-2048x64 spectrometer. Experimental data showed that in the spectral range 300-400 nm the NTCDI absorption peaks at 360 and 380 nm are observed.

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