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Getting of Nanocomposites Thin Films on the Basis of Carbazole from Gas Phase and their Properties

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Technology of gas-core deposition of two-three component composite materials and heterostructures on the basis of carbazole is worked out, thin films of carbazole-contained composite materials with CdSe acceptors, C_{60}, TNF are got. In optical spectrum of composite materials films the complex stripes with charge transferring are present.

Kewwords: Carbazole, Gas-core deposition, Nanocomposite, Acceptor, Technology.

PACS numbers: 68.35.bm, 68.55.am

1. INTRODUCTION

Carbazole-contained films of organic semiconductor found a wide use in elecrtophotography [1, 2]. In these materials quantum efficiency of photogeneration reaches 0,9 in electric fields with tension of 100 MV/m [2]. Carbazole composite materials films with acceptors or dies are often applied by watering from solutions, what appreciably limits a composite materials components choosing in sign of solubility, especially at getting of heterosturcutres, and also limits a film thickness with micrometer and submicrometre meanings. It is also known an use of films of carbazole-contained semiconductors for planar conduits [3]. The unique copolymers [4] and carbazole composite materials with carbonic nanotubes are got, with covalent tying up over third carbonic carbazole atom [5]. Last materials, found their use in chemical batteries in fuel elements, have got by electrochemical methods in oxidizing conditions. In [2, 6-12] is reported about carbazole using in luminous radiated devices technology, solar photoreformers and sensors. In these devices multilayer structures are used from films by the thickness of the order of a hundred of nanometers with a considerable conductivity. The appearance of last objects became more possible in result of using of deposition methods from gas phase [2, 10, 13]. It is known that carbazole composite materials with fullerenes are high-temperature superconductors [14].

Realization of so wide combination of various electronic and optical composite materials properties on the basis of carbazole testifies about rich possibilities of using various processes of these nanocomposites organizations in the result of valent interactions, covalent tying up, including a taking part with free radicals and originators, polymerization and copolymerization and also oxidizing-reconstructive processes with taking part of carbonic nanotubes.

In [11] is reported about evaporation of polymeric PVC. It is evident that a deposition from PVC type polymer gas phase must be accompanied by chemical reactions of polymeric chain fragmentation, crossing of fragments (possibly of radicals) in gas phase, gas-core or in molecular fascicles by transferring partial recombination of fragments, by condensation, by self-organization in adsorptive layer, saturation of covalent ties, and, possibly, by polymerization. Gas-core deposition grants a rich instrument outfit and means for manipulation by these factors with the purpose of getting carbazole composites with unique properties.

The purpose of this work is a getting of thin films (by the thickness from tens of nanometers to ones of micrometers) on basis of carbazole-contained organic junctions by deposition from gas phase, getting of composites with acceptors and also a fixing of conformities in their optical properties changes.

In quality of object researching a poly-*N*-vinylcarbazole (PVC) is chosen as a various studied model junction. For getting nanocomposites some strong acceptors of different nature were used: cadmium selenide, fullerene C_{60} and trinitrofluorenon (TNF), got by vacuum evaporation.

2. EXAMPLES PREPARATIONS

Nanocomposites films were got in vacuum from some sources by the way of transferring of components into a gas phase and combined deposition. Thin films were got by transferring into a gas phase in oligomers vacuum of poly-*N*-vinylcarbazole with molecular mass to 10000 and 9-vinylcarbazole monomer, by steams transporting and by further condensation of back. For transferring into gas phase thermal heating and electronic fascicle activation with current 3-10 mA and energy 600-1000 eV was used.

The experiments are investigated on vacuum set VPC – 5 M (Fig. 1), equipped with three evaporators, sensors of molecular stream on basis of quartz resonators, back transport system in camera and computer-assisted control system in methods [15-18]. Backs 2 were transferred with the help of transportation system of examples 3, 4, 16 and were screened by mobile oven door 5. For optical examples spectrums their placement was realized in conduit aperture 10 of spectrometer 15. Copper screens 6, 7, 8, which are placed around evaporators, and water cooling system 11 provided a given controllable evaporation mode. Every evaporator is equipped with precision power source 17, 18, 19, which was controlled with the help of computer and camera and ensuring of given evaporation and condensation modes.

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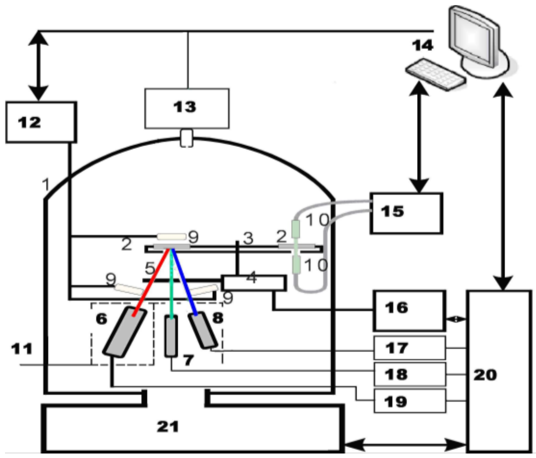

Fig. 1 – Installation scheme for applying of multicomponent nanocomposites films by deposition from gas phase

Pressure sensor and controller 13 gave an information relatively a pressure in camera. Controlled computer 14 treated an information from controllers 12, 13, 15, 16, ingenuously or over ADC-DAC reorganizers 20, with the purpose of realization of standard manipulations in vacuum.

Evaporation of most polar organic molecular junctions is unstable at constant temperature of sublimator, what causes the problems for getting multicomponent composites of given composition [15]. Therefore for getting nanocomposites films with given distribution of components in film thickness and integral composition the automatic regulation system of films raising process was used.

Evaporator A1 gives a growth speed of all composite and often is used for evaporating of component with the biggest mass, so a matrix. Oven doors 5 provided a regulated stream from molecular fascicles on bottom layer, and also an ending of films growth at their determined thickness. Information relatively to molecular fascicles density arrived to control system from three dependent quartz resonant sensors, which were placed in matched molecular fascicles (fig. 2).

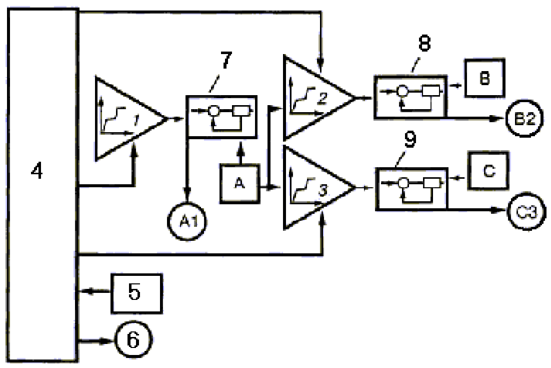

Fig. 2 – Functional scheme of structure regulation of multicomponent nanocomposite films, got by deposition from gas phase. 1, 2, 3 are program modules of growth speed control and film components thickness, A1, B2 и C3 are evaporators, A, B, C are quartz sensors, 4 is a control module, 5 is a spectrophotometer, 6 is an oven door, 7, 8, 9 are PID regulators

Quartz mass witness sensors signals for every film components were used for molecular streams controlling in a real scale of time. Quartz sensors perceptibility made up $6 \cdot 10^{-8}$ kg/m^2, programmatically frequency drift didn't exceed 10 Hz/h. A necessary profile of component concentration in composite film thickness and growth kinetics was programmed as target functions. For transferring of bottom layers in camera in films sputtering process controlling-program manipulator of planetary type was used. Bottom layer exposition in fascicles of sublime molecules and free radicals was realized with the help of controlled oven doors. Spectrophotometer allows to register the spectrums of film absorption spontaneously in growth process, and also to research and to control the processes of chemical interaction, aggregation and molecules adsorption in composites. Complex programming has been executed by LabVIEW language.

For demonstration of methods possibilities and technological set at fig. 3 a temporary dependence of heterostructure growth process on basis of CdSe / PVK nanocomposite is shown.

At first PVC layer was applied, then a simultaneous evaporation CdSe and PVC was happening. At $t = 770$ c an evaporation speed of CdSe was increased so that to create a CdSe / PVC structure with a concentration gradient. Then an PVC evaporation was terminated and structure applying was finished by CdSe thin layer.

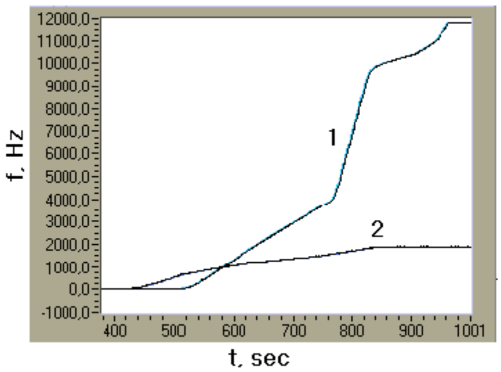

Fig 3 – Quartz sensors frequency changing of mass components in heterostructure growth process on basis of CdSe / PVK nanocomposite: 1 – CdSe; 2 – PVC

3. NANOCOMPOSITES FILMS PROPERTIES

Optical homogeneous films by the thickness of 30 nm-3 μm of carbazole nanocomposites with acceptor

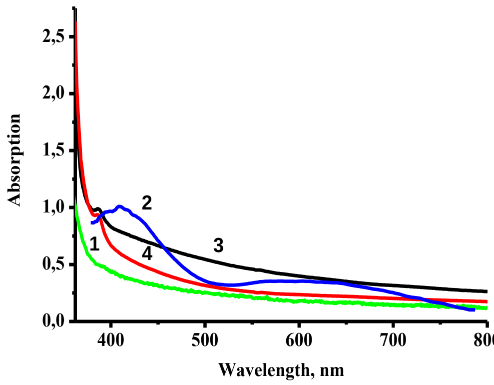

Fig. 4 – Optical absorption spectrums for composites on basis of PVC: 1 is an PVC initial substance, 2 is a CdSe / PVC composite 15 % mass, 3 is a C_{60} / PVC composite 11 % mass, 4 is a TNF / PVC composite 15 % mass

junctions are got by codeposition from gas phase, which absorption spectrums are shown at fig. 4. Using of additional activation of gas-core products by thermions didn't lead to spectrums absorption changing in range of 350-900 nm [19]. Absorption stripes of 550-760 nm for composite CdSe / PVC, 480-800 nm for composite C_{60} / PVC, and 480-700 nm for TNF / PVC are absent in absorption spectrums of individual initial substances. The position of these stripes is close to famous [1, 2] complexes stripes with charge transferring in correspond composites, got from a solution.

4. CONCLUSIONS

An automatic technological equipment and methods of gas-core deposition of 2-3 component composites and heterostructures on basis of carbazole are developed.

Thin films of carbazole-contained composites with acceptors CdSe, C_{60}, TNF are got by deposition from gas phase. In optical spectrums of composites films the complexes stripes with charge transferring are present.

Получение тонких пленок нанокомпозитов на основе карбазола из газовой фазы и их свойства

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Разработана технология газофазного осаждения 2-3 компонентных композитов и гетероструктур на основе карбазола, получены тонкие пленки карбазолсодержащих композитов с акцепторами CdSe, C_{60}, TNF. В оптических спектрах пленок композитов присутствуют полосы комплексов с переносом заряда.

Ключевые слова: Карбазол, Газофазное осаждение, Нанокомпозит, Акцептор, Технология.

Отримання тонких плівок нанокомпозитів на основі карбазолу з газової фази та їх властивості

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Розроблена технологія газофазного осадження 2-3 компонентних композитів та гетеро структур на основі карбазолу, отримання тонкі плівки карбазолвмісних композитів з акцепторами CdSe, C_{60}, TNF. В оптичних спектрах плівок композитів присутні смуги комплексів з переносом заряду.

Ключові слова: Карбазол, Газофазне осадження, Нанокомпозит, Акцептор, Технологія.

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