Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 103 (2017) 75 – 81

Procedia Computer Science

XIIth International Symposium «Intelligent Systems», INTELS'16, 5-7 October 2016, Moscow, Russia

The conduct of organic compounds applied to information display devices

V.V. Belyaev*, D.A. Suárez, J.M. Atiencia

RUDN University, 6 Mikluho-Maklaya st., Moscow 117198, Russia

Abstract

Materials science is an interdisciplinary field where physicists, chemists and engineers work together, bringing different views on the same problem in their quest to find a common goal of development and improvement of many existing materials in nature. The main goal of materials science is to respond to the needs of contemporary society through innovation. Some of the topics being addressed at the moment are the reduction of energy consumption in devices, how to encourage increased energy storage capacity of batteries, development of systems offering based on renewable energy solutions and, therefore, they are able to capture energy from sunlight among other things. Organic semiconductors are able to offer solutions to the various problems that we face today, through the intelligent use of their intrinsic properties (they are cheap, flexible, transparent and light), allowing lead to new concepts and designs of electronic devices. The best example is found in the organic light emitting diodes (OLEDs). Were the first devices based on organic materials produced on a large scale and have revolutionized the display industry by offering hardware that consumes much less power and offers higher quality, in addition to using less physical space. Today we can find in mobile phones and the ultra-thin, high-resolution TVs, enabling unique solutions such as televisions and curved transparent screens. Today, the OLED industry is well advanced and it is possible to find highly efficient devices on the market. The challenges now we find them in improving display properties and the development of lighting devices for interior spaces and architectural purposes among other developments.

Peer-review under responsibility of the scientific committee of the XIIth International Symposium "Intelligent Systems"

Keywords: materials science; organic semiconductors; organic emitting diode (OLED); display properties and development of lighting devices.

* Corresponding author Tel. +7-916-3864705,
E-mail address: vic_belyaev@mail.ru

1877-0509 © 2017 Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Peer-review under responsibility of the scientific committee of the XIIth International Symposium "Intelligent Systems"
doi:10.1016/j.procs.2017.01.015

1. Introduction

As of today, there are two design and technological solutions for the data display devices, built on the basis of organic materials that have found industrial implementation - it is an Active Matrix OLED, AMOLED and Passive Matrix OLED, PMOLED. Displays based on the organic LEDs belong to the category of flat panel display devices. Basically it is phosphorescent AMOLED, because they have better optical data compared with the fluorescent[1,2]. PMOLED are also used, but more often as indicator displays of low resolution.

Among the great number of the applicable for use organic conductive polymers the most studied materials based on polythiophenes, polyphenylamines, polypyrroles, and a variety of phthalocyanines[2].

The conjugated polymers have already attracted the attention of researchers due to the wide range of potential applications, related to their semiconductor properties, for a long time. Significant progress in the field of conductive polymers has been achieved in the development of new conjugated polymers containing pendant group. This not only greatly facilitated the synthesis of some electroactive polymers and allowed simultaneously to vary the properties of the interface system, which in turn greatly enhances the practical application of these materials. Several researches have shown that the impurity of the electron-donor alkoxy-substituent reduces the oxidation potential of the polymer, thereby increasing its stability in the conductive state. In the reseaches[3,4,5] were experimentally confirmed that the presence of the flexible pendant group and a variety of counterions can significantly alter the properties and stability of the doped systems, as well as to increase the solubility of the polymer.

The widely known today PEDOT - material based on poly-3, 4-ethylenedioxythiophene which are capable with pronounced electrochromic properties applies to the number of organic electronics materials on the basis of substituted polythiophenes.

For the first time the LEDs based on polythiophene were demonstrated in 1991 in the research, wherein the poly (3-alkylthiophenes) are represented as a red-orange-emitting materials in ITO / PT / Mg: In monolayer devices.

There are several types of thiophene-based materials (thiophene homopolymers and oligomers, copolymers of thiophene and copolymers of thiophenes with other conjugated moieties: thiophene-phenylenes, thiophene-fluorenes, poly (thienylenevinylenes), thiophene-silatsiklopentadieny thiophene-silole copolymers, thiophene copolymers with other electron-deficient heterocycles in the main chain) which are used in the light-emitting devices. By changing the structure of the substituent and the accompanying changes in distortion of the base their colour of the emission can be changed in a wide range - from blue to deep red, and even in the near IR-range. Polythiophenes (PT) develops a strong tendency to aggregate, which reduces the efficiency of the photoluminescence and electroluminescence radiation, but this can be minimized to some extent by the injection of the bulk substituents. The low FET emissivity in comparison with other major category of light emitting polymers such as polyphenylenevinylene and polyfluorene, have already observed in the solution. This can be partly explained by the effect of "heavy element", which facilitates the transition to the triplet state with the accompanying decrease of fluorescence efficiency. There is the extra problem which is additionally emphasized by the tendency of the PT aggregation in the EL-devices[6].

The greatest varieties of the emission wavelengths and the most effective EL-materials have been established with copolymerizing of thiophene with other conjugated monomers. The "Dilution" in this way of thiophenic sections of the polymer chain with aromatic moieties can increase the bandgap of the material, thereby obtaining the blue-emitting thiophene copolymers, and in many cases it suppreses the aggregation in the solid state (thereby improving the radiation efficiency). The copolymerization with electron-deficient comonomers (well known as the alternating donor (D) - aktseptor (A) polymers, D-A-D-A) results in the reducing of the bandgap that allows you to create the light-emitting materials with intense red or even infrared luminescence. In many cases, the creation of such copolymers with the narrow-bandgap includes the combining of -A-A-moiety with the low-bandgap (thiophene plays as a donor in it) and the moiety with more wide-bandgap (for example, fluorine is known as building block for high-performance light-emitting polymers and copolymers)[6].

The described features of the polythiophene-based materials make them promising for the creation on their basis of the competitive PSIDov emitting in the red and near infrared region of the spectrum and the synthetic universality of the thiophenes also makes them very attractive building blocks for the multicomponent-light-emitting copolymers when it requires the precise stitching of the all components properties.

The composites based on polyphenylamine (PANI) and the nanoscale organic molecular crystals can be used in the high-efficiency OLEDs. For the first time there are the organic nanoscale crystals - J-aggregates - molecular