Chapter 1

Introductory Chapter: Why the Study of Fullerenes is so Important?

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1. Introduction

It is known that the use of the laser technique has been dramatically activated from the 1960's. Due to the reason that the lasers are operated at different spectral range and at different energy density (power), the scientists and engineers have had the task to find the novel materials to protect the human eyes and technical devices from high laser irradiation. Moreover, the modern solar energy, gas storage, and biomedicine elements have searched for the new sensitizers with good advantage as well.

In this aspect, the science history and nature permits to resolve this task [1–7]. From David Jones experiments (1966) and E. Osawa calculations (1970); from E. Colder experiments (1984), and from H.W. Kroto, R.E. Smalley, R.F. Curl consideration (1985), the fullerenes have been discovered and have got their name on 1985. Indeed, it provokes the future investigation. Thus, the carbon nanotubes (CNTs) have been opened in 1991. Now, these nanostructures have an important advantage in the modification of the surface and the body of inorganic and organic materials.

The main reason to use the fullerenes is connected with their unique energy levels and high value of electron affinity energy. Only S_1-T_1 transition has the time close to 1.2 ns, but the higher transitions from the exited singlet or triplet states have the time in the pico- or femtosecond range. Thus, the study of the fullerene and relative systems dynamic in the nano-, pico-, and femtosecond regime is actual, and the investigation of the ionization and fragmentation of fullerenes with different approaches are important. Moreover, the fullerenes have the large value of the electron affinity energy close to 0.65–0.7 eV. That is larger than the one for most dyes and organic molecules *intra*molecular acceptor fragment. It can stimulate the efficient *inter*-molecular charge transfer complex (CTC) formation in the fullerene-doped organic conjugated materials. Regarding the CNTs, it should be necessary to take into account the variety of charge transfer pathways, including those along and across a CNT, between CNTs, inside a multiwall CNT, between organic molecules and CNTs, and between the donor and acceptor moieties of an organic matrix molecule. The data presented in **Figure 1a** and **b** show the possible mechanism of charge carriers moving in the fullerene-, carbon nanotubes, and relative nano-objects-doped organic materials. Moreover, the bio-objects based on DNA can be added to this consideration. Some theoretical and experimental results about the process shown in **Figure 1** have been previously presented in the papers [8–15]. It should be remarked that the polarizability of the sensitized organic composites is larger than the one for the pure polymer or the liquid crystal matrix due to the formation of the larger dipole moment under the sensitization process.

The basic features of carbon nanotubes are regarded to their high conductivity, strong hardness of their C─C bonds, complicated and unique mechanisms of charge carrier moving, and large surface energy [16–22]. Moreover, the CNTs refractive index *n* is so small, namely, it is placed in the range of 1.05–1.1. Different types of the optical materials, especially inorganic ones, can be treated by CDV, PDV, laser ablation, laser oriented deposition, etc. technical methods, to deposit the CNTs on the materials surfaces in order to develop the novel coatings. Indeed, it can provoke the change of the refractivity, spectral, mechanical, and wetting phenomena of the composites. Analytical and quantum chemical simulations have supported the experimental results. Some accent has been given to form the covalent bonding between the atoms of carbon nanotubes and near-surface atoms of the matrix materials, see **Figure 2**. It provokes the dramatic increase of the transparency, mechanical hardness, laser strength, wetting angle, etc. parameters [23–27].

In the current “Fullerenes and relative materials” book, namely eight chapters are placed. They are devoted to study the fullerenes C_{60} and C_{70}, as well as the polymeric phase of fullerenes and their derivatives under high pressure and high temperature. The interesting results are presented about the possibility to encapsulate of 3–10 nitrogen atoms into the C_{70} cage.

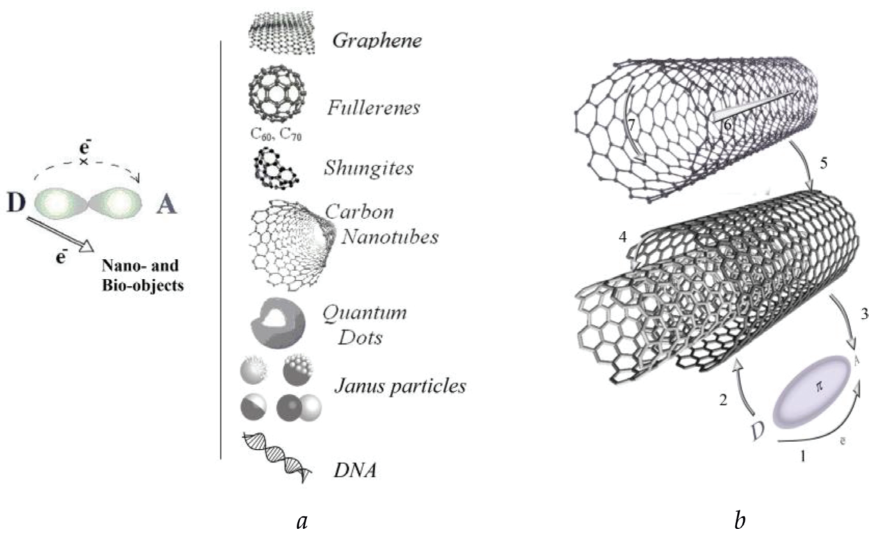
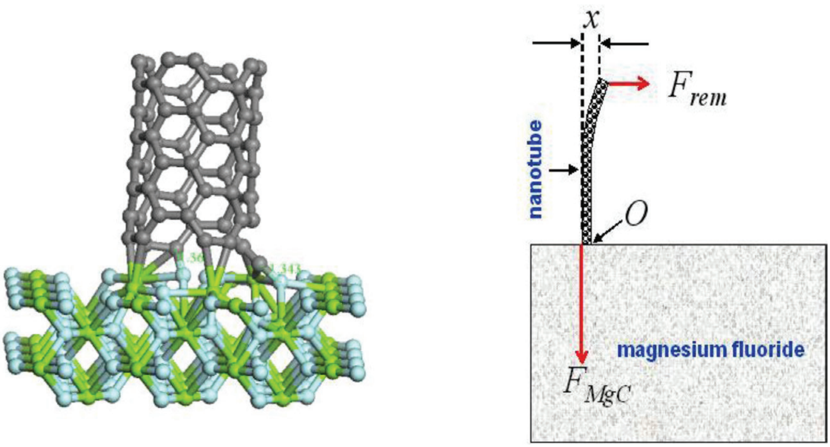


Figure 1. The possible mechanisms of CTC formation in the nano- and bio-objects-doped conjugated organics (a) with the selection of possible charge transfer on the CNTs basis (b).



a b

Figure 2. Possible covalent bonding formation in the systems of MgF_2-CNTs (a) [24] and analytical calculation of this process (b) [25].

Raman spectrum of hydrogenated carbon film deposited by dc-pulse plasma CVD has been analyzed, and the process of the hybridization of graphene fragment, which limits the nucleation and growth of onion-like nanoparticle, has been shown. Optical, nonlinear optical, and mechanical features of the nano-objects containing composites are presented and supported by the analytical and quantum-chemical simulations.

All chapters present the results about the unique properties of the materials studied in the different area of their applications, including the general optoelectronics, solar energy and gas storage, laser and display, biomedicine, etc. It is important for the education process and for the civil and special device operation. The advanced idea, the special approach, and the information described in the current book will be fruitful for the readers to find a sustainable solution in a fundamental study and in the technique. The book can be useful for the students, post-graduate students, engineers, researchers, and technical officers of optoelectronic universities and companies.

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Conflict of interest

There is no conflict of interest.

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