World Academy of Science, Engineering and Technology
International Journal of Biotechnology and Bioengineering
Vol:9, No:05, 2015

DNA Nano Wires: A Charge Transfer Approach

Authors : S. Behnia, S. Fathizadeh, A. Akhshani

Abstract : In the recent decades, DNA has increasingly interested in the potential technological applications that not directly related to the coding for functional proteins that is the expressed in form of genetic information. One of the most interesting applications of DNA is related to the construction of nanostructures of high complexity, design of functional nanostructures in nanoelectronical devices, nanosensors and nanocercuits. In this field, DNA is of fundamental interest to the development of DNA-based molecular technologies, as it possesses ideal structural and molecular recognition properties for use in self-assembling nanodevices with a definite molecular architecture. Also, the robust, one-dimensional flexible structure of DNA can be used to design electronic devices, serving as a wire, transistor switch, or rectifier depending on its electronic properties. In order to understand the mechanism of the charge transport along DNA sequences, numerous studies have been carried out. In this regard, conductivity properties of DNA molecule could be investigated in a simple, but chemically specific approach that is intimately related to the Su-Schrieffer-Heeger (SSH) model. In SSH model, the non-diagonal matrix element dependence on intersite displacements is considered. In this approach, the coupling between the charge and lattice deformation is along the helix. This model is a tight-binding linear nanoscale chain established to describe conductivity phenomena in doped polyethylene. It is based on the assumption of a classical harmonic interaction between sites, which is linearly coupled to a tight-binding Hamiltonian. In this work, the Hamiltonian and corresponding motion equations are nonlinear and have high sensitivity to initial conditions. Then, we have tried to move toward the nonlinear dynamics and phase space analysis. Nonlinear dynamics and chaos theory, regardless of any approximation, could open new horizons to understand the conductivity mechanism in DNA. For a detailed study, we have tried to study the current flowing in DNA and investigated the characteristic I-V diagram. As a result, It is shown that there are the (quasi-) ohmic areas in I-V diagram. On the other hand, the regions with a negative differential resistance (NDR) are detectable in diagram.

Keywords : DNA conductivity, Landauer resistance, negative differential resistance, Chaos theory, mean Lyapunov exponent
Conference Title : ICMBB 2015 : International Conference on Molecular Biotechnology and Bioinformatics
Conference Location : Rome, Italy
Conference Dates : May 05-06, 2015