Short Communication:

Organic Nanoelectronics: New Generation Semiconductors

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Most of us know about conductor as it carries electric current and electricity has reached now in every house even in remote villages. Metals are generally good conductors of electricity. On the other hand, insulator prevents current in electrical appliances. Nonmetallic elements are generally very poor conductors of electricity. There are superconductors which carry electricity at very low temperature in an efficient way. Interestingly a semiconductor is capable of conducting current when it is doped properly. Unlike metallic conductor, its resistance decreases with temperature.

In late 1970s, scientists found plastic materials with some special characteristics are capable of conducting electricity.[1] It has opened up a new era of organic semiconductor because plastics are nothing but polymers of extremely high molecular weight organic material which are built up through interconnection of small organic molecules (monomer) through covalent bond. Incorporation of labile electron into polymeric backbone was the basic idea of conducting polymer. The area of nanoscience and nanotechnology has grown tremendously over the past two decades and is expected to expand more extensively in the near future.[2,3] Recently developed concept using organic nanomaterial (dimension in any direction < 100nm) as a semiconductor is an emerging research area for the academicians and industrial research professionals.[4-10]

The giant industries of developed and developing countries are investing huge amount of money to develop and apply the organic electronic technology, especially the organic electronic semiconductors. The new generation organic/organic-nanoelectronic semiconductors will find wide spread application in semiconducting electronic devices such as organic field effect transistor (OFET),[11] light emitting diode (OLED),[12] nonvolatile memory switches like resistive random-access memory (ORRAM) and write once read many (OWORM),[13] solar cells, batteries, capacitor, negative-capacitor and even lasers. In brief, organic electronic is a branch of science and/or technology that deals with conductive organic compounds as materials which are made of carbon based nonmetallic materials.

Organic semiconductor has several advantages over its inorganic counterpart. The later requires high degree of purity of the materials, rigid crystalline structure limited to only few materials (Si, Ga, As) suffering from magnetic interference. On the other hand, organic electronic products are lighter, more flexible, environmentally benign (biodegradable), less expensive, non-magnetic and available in purest form. Semiconducting property can easily be modified through changing shape, chemical structure, installation of a wide range of functional groups and fabrication of nanomaterials which in turn generates innovative semiconducting, conducting, photo-luminescence, storage, display and other performances to achieve highly efficient new generation electronic devices. Thus, it will open up new window to many exciting and advanced new applications that would be impossible with currently used inorganic materials as backbone of electronic industry.

Semiconductors are of two types. When doping is made to electron deficient molecule, a positive hole is created which acts as charge carrier, this is known as p-type semiconductor; and if doping is done by electron reach molecule, n-type semiconductor is generated. Gratifyingly the band gap is in the broad range for organic semiconductors and it is typically 2–4eV whereas band gaps for commonly used inorganic semiconductors are in narrow range 1–2eV. Thus, one may consider these components as insulators rather than semiconductors in the conventional sense. They become semiconducting only when charge carriers are either injected from the electrodes or generated via intentional or unintentional doping. Charge carriers can also be generated in the course of optical excitation. Dielectric constants of organic semiconductors are as low as 3-4.

The schematic diagram explains how a highly efficient device can be made by utilizing new generation innovative organic semiconductors. The main advantage of organic semiconductor fabrication is to achieve an assembly of a fully flexible insulating film without any substrate. It is possible to expose the gate side of the film to an external medium to apply to any kind of substrate. Compared to silicon structures, organic materials have fully flexible structures, require only low voltages comparable with the performance for solution monitoring and some innovative applications which are practically impossible for silicon based devices even for system embedded in textiles and smart food packages.

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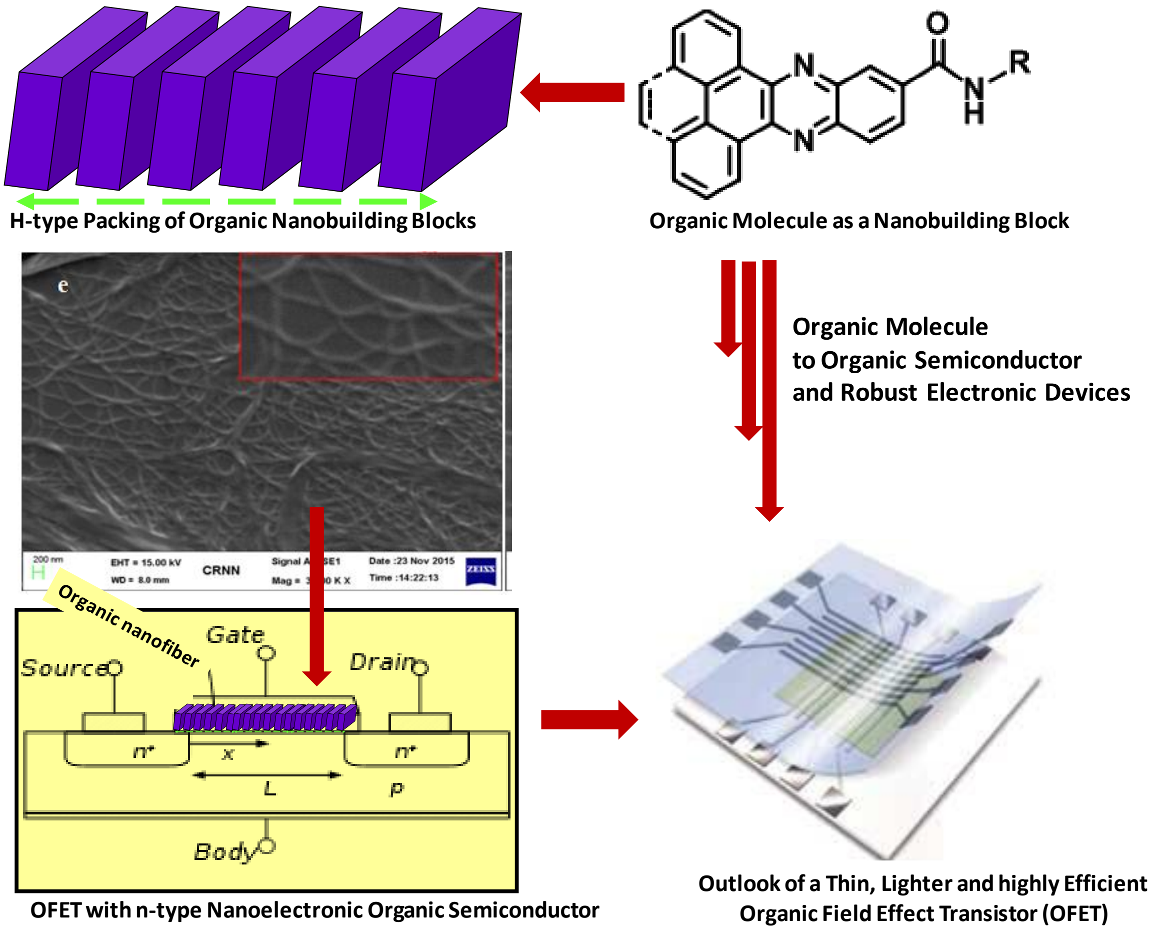

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(Received 14th March 2018, accepted 28th March 2018)

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