PREFACE

Nowadays, organic electronics are playing very important role to provide a flat and flexible platform to the electronic industries. It promotes the progress of plastic electronics due to the light-weight and flexible property of organic semiconductors. Organic semiconductors have many advantages over the traditional semiconductors, such as, very good solution processibility, mechanical flexibility, and compatibility with a number of flexible substrates. Therefore, organic electronics is a promising scientific area of worldwide active research and prospective huge technological and commercial applications. Organic devices can be fabricated at low-cost with wide coverage area even at low temperature. Organic electronics is biodegradable in nature because it consists of carbon atom; hence, it has the possibility to blend with food and medical systems where inorganic electronics are not applicable.

Amongst various organic semiconductors, poly-3-hexylthiophene (P3HT) is generally studied and applicable p-type active material due to its admirable properties such as good solubility, processibility, regioregularity, relatively high field-effect mobility, wide commercial availability, and chemical stability which make this material appropriate for various micro and nano organic electronic devices and their applications such as organic solar cells, light-emitting diodes, memory devices, smart cards, sensors and organic field effect transistors. Stable functionality of P3HT makes it more suitable for Organic Field Effect Transistors fabrication (OFET).

Since last twenty five years, OFETs are receiving very much curiosity owing to their low-cost, light-weight, and flexible fabrication properties and therefore they are generally used as basic building block elements in modern micro and nano organic electronic devices. They have wide area of prospective applications such as in digital switches, large-area display devices, gas sensors, RF identification tags, smart cards *etc*. The progress in OFETs depends on many issues such as enhancement in device performance, decrement in fabrication cost, and expansion in the area of applications. The major drawback of OFETs is its poor field-effect mobility which confines their use for high speed devices applications.

In this study, OFETs were fabricated by using P3HT as the host active channel semiconductor material that was synthesized in the laboratory at ambient conditions. It is well known that the performance mainly the mobility of an OFET is strongly dependent on its active channel material, thin-film morphology and orientation of the molecules in the channel film. Therefore, here, we tried to improve the performance of the P3HT FET simply by changing the morphology of P3HT as P3HT-nanofibers, P3HT-naocomposite by incorporation of a few graphene sheets, and also by doping of P3HT with a very good electron acceptor 7,7,8,8 tetracyanoquinodimethane (TCNQ). It was found that the OFET performance improved significantly in each case due to improved transport property of the device channel film.

Graphene flakes added into the P3HT thin-film would provide “fast tracks” or work as Conduction Bridge for the charge carriers. As a result, the carrier mobility of P3HT/graphene based OFETs gets enhanced drastically compared to the mobility of only P3HT based FETs.

The P3HT-nanofibers thin-film coated on OFET channel shows very good electrical conductivity due to end to end charge carrier transfer, which makes improved electrical properties with improved mobility, on/off ratio and all other key performance parameters of the P3HT-nanofibres based OFETs.

Much improvement in mobility of the carriers in OFET was observed for the TCNQ doped P3HT transistor. However, the on-off ratio decreased for high doping.

The drawback associated with high doping was overcome by coating of an ultra thin-film of aluminum in the highly doped device channel. Here, the mobility improved by about two orders and the on/off ratio also enhanced by about three orders along with the improvement in the other essential device parameters compared to P3HT FET performance. Thus the best performance of the OFET fabricated and studied in this research was observed for ultra thin aluminum coated high TCNQ doped P3HT FETs.