Public Abstract

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Title:THE USE OF FERROELECTRICS AND DIPEPTIDES AS INSULATORS IN ORGANIC FIELD-EFFECT TRANSISTOR DEVICES

While the electrical transport characteristics of organic electronic devices are generally inferior to their inorganic counterparts, organic materials offer many advantages over inorganics. The materials used in organic devices can often be deposited using cheap and simple processing techniques such as spincoating, inkjet printing, or roll-to-roll processing; allow for large-scale, flexible devices; and can have the added benefits of being transparent or biodegradable.

In this manuscript, we examine the role of solvents in the performance of pentacene-based devices using the ferroelectric copolymer polyvinylidene fluoride-trifluoroethylene (PVDF-TrFe) as a gate insulating layer. High dipole moment solvents, such as dimethyl sulfoxide, used to dissolve the copolymer for spincoating increase the charge carrier mobility in field-effect transistors (FETs) by nearly an order of magnitude as compared to lower dipole moment solvents. The polarization in Al/PVDF-TrFe/Au metal-ferroelectric-metal devices also shows an increase in remnant polarization of ~20% in the sample using dimethyl sulfoxide as the solvent for the ferroelectric. Interestingly, at low applied electric fields of ~100 MV/m a remnant polarization is seen in the high dipole moment device that is nearly 3.5 times larger than the value observed in the lower dipole moment samples, suggesting that the degree of dipolar order is higher at low operating voltages for the high dipole moment device. This work shows that the performance of electronic devices can be improved simply by selection of fabrication materials, potentially opening up simpler fabrication processes for large scale manufacturing of organic electronics.

We will also discuss the use of peptide-based nanostructures derived from natural amino acids as building blocks for biocompatible devices. These peptides can be used in a bottom-up process without the need for expensive lithography. Thin films of L,L-diphenylalanine micro/nanostructures (FF-MNSs) were used as the dielectric layer in pentacene-based FETs and metal-insulator-semiconductor diodes both in bottom-gate and top-gate structures. It is demonstrated that the FF-MNSs can be functionalized for detection of enzyme-analyte interactions. This work opens up a novel and facile route towards scalable organic electronics using peptide nanostructures as scaffolding and as a platform for biosensing.