Electronic properties of junctions between aluminum and undoped/doped poly(2,5-dimethoxyaniline)

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Introduction

Processability and solubility of polymers are of prime importance in the field of polymer device physics. Electrically conductive polymers such as polyacetylene, polypyrrole, and polythiophene, polyaniline is expected to be an important role for electronic device [1, 2]. However, most conducting polymers such as polyaniline are still insoluble owing to the stiffness of their backbone, restricting their further applications. In recent years, several research studies have been directed to improve the solubility of polyaniline in organic solvents to enable its utilization for suitable applications.

2,5-dimethoxyaniline (DMA), has been reported to produce soluble polymers, poly(2,5-dimethoxyaniline), (PDMA) with a conductivity similar to polyaniline [3]. According to the advantages of PDMA, we have concentrated on the devices that use PDMA as an active semiconductor. Owing to importance and simplicity of fabrication of Schottky diodes, it was decided to study the behavior variation of undoped and doped form of PDMA. In the present work, we would like to report the electronic properties of junctions between undoped/doped PDMA and Al by using the IV characterization, augmented with the UV-Visible spectrum analysis.

Results and Discussion

Upon doping (in most cases oxidizing) polymers, new electronic states are created in the energy gap. The presence of these states in the forbidden gap provides new optical transitions in addition to the interband transition. Figure 1 show the UV-Visible spectrum of doped and undoped form of PDMA. In this optical absorption spectrum, the peak (at around 580 nm) was shift to high wavelength (at around 860 nm) due to doping process.

The electric properties of the Schottky barriers are studied in a sandwich assembly. According to the Schottky barrier theory, semiconductors form a rectifying barrier at the interface when the work function of metal is smaller than that of the semiconductors, such as in a sandwich structure of Au/PPy (PSS)/Au, where polypyrrole, is doped with polystrylenesulfonate, PSS^-, the device gives an ohmic I-V characteristic (rather than rectifying). Figure 2 (a) and (b) show the *I-V* characteristics of the Al/ PDMA (doped with H_2SO_4)/Al and Al/PDMA (undoped form)/Al devices. The *I-V* curves are symmetric and nonlinear. At lower values of the bias voltage, the junction became highly resistive. The device of doped form of PDMA clearly exhibit rectifying behavior in the room temperature. The turn on voltage for the doped sample is much smaller than the undoped one. In fact, intrinsic semiconductors having the neutral number density of charge carriers are poor conductors, and only on adding very small amounts of dopants, i.e., electron-deficient or electron-rich atoms, does the conductivity increase the useful level.

References

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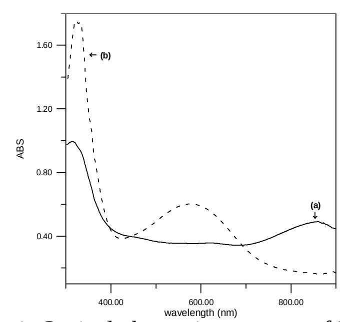

Figure 1. Optical absorption spectra of PDMA (a) Doped form (doped with H_2SO_4) and (b) undoped form.

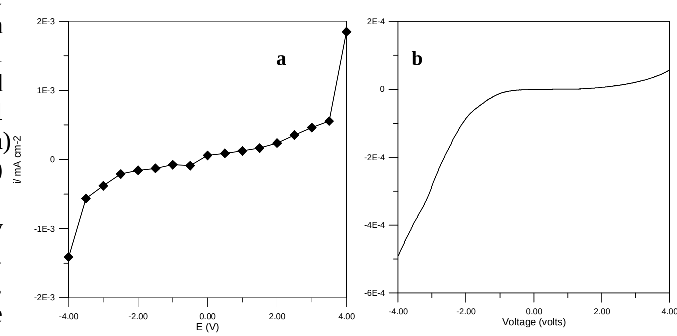

Figure 2. Current-voltage characteristics of (a) Al/ PDMA (doped form)/Al and (b) Al/ PDMA (undoped form)/Al sandwich structures.