Journal of Fluorescence
https://doi.org/10.1007/s10895-023-03448-0

RESEARCH

Synthesis, Surface Morphology, Gas Sensor, DSC Technique and Third-Order Behavior of Conducting Polymer

Fadhil A. Tuma[1] · Alyaa A. Jari[2] · Harith A. Hasan[3] · Hussain A. Badran[1]

Received: 27 August 2023 / Accepted: 20 September 2023

Abstract

The compound polyaniline (Poly-ANI) with different concentrations of (H_2SO_4) sulfuric acid has been synthesized by the chemical polymerization method. The prepared compounds have been characterized using number of techniques including FTIR, FE-SEM, EDS and DSC. Additionally, UV–Vis spectroscopy employed for studying the linear optical properties of polymer with different acid concentrations. Third order optical nonlinearity was characterized using Z-scan at 532 nm. The results showed that the nonlinear refractive index has a negative sign. It was observed that the nonlinear refractive index changes in different ratios of H_2SO_4. The high value of nonlinear refractive index (n_2) obtained along Z-axis is 74.62×10^{-7} cm^2/W, and the corresponding χ^3 is 21.5×10^{-5} esu. Also, the Poly-ANI film shows the response to NH_3 gas sensing in the range 20 ppm-250 ppm and can be used for NH_3 sensing application.

Keywords Chemical polymerization · DSC · Conduction band · Bipolarons · Open aperture

Introduction

A conductive polymer (COP) is a polymer that has semiconducting or even conductive properties by chemically or electrochemically doping its vertebral column with a double conjugated bond. The main conductive polymers, such as p-phenylenevinylene (PPV), poly-pyrrole (PPY) and Poly-ANI, are applied to a wide range of areas, including phototherapy, EMI shielding, photovoltaic solar cell, long life battery storage, membrane gas separation, microwave absorption, sensitive chemical sensors and corrosion protection [1–4]. Among the class of conductive polymers Poly-ANI, which is one of the important polymers, Poly-ANI is a unique conductive polymer compound that has unique linear optical and electrical properties and offers the benefits of simple synthesis, stability of the environmental, affordability and flexible control of electrical characteristics through doping and load-transfer protonation [5–8]. The compound has been of interest since 1980, which is thermally and environmentally stable where Poly-ANI is found in a basic (insulating) form or in the form of a conductive salt and it is in various of shapes that differ in its physical and chemical properties [9, 10]. Negative permeability [11] and physical properties of giant magnetoresistance [12] have been studied for Poly-ANI. As a result of the exceptional qualities that it has, it has applications in a variety of fields, including electrochromic lenses [13], solar cell applications [14], light-emitting machines [15], optical, thermal, and bio-sensors [16, 17], super-capacitors [18], neural prosthesis/biotic-abiotic interfaces [19], pigments [11], distribution systems [20–22], separating membrane gases [23–25] and medicine [12].

The study of polymers that possess electrical, optical and electrooptic characteristics has received a significant amount of interest in recent years [26]. Electrically conductive polymers, such as polyaniline, polyfuran, and poly(o-methoxyaniline) are widely used in a variety of sectors due to the fact that they have a number of desirable qualities, such as being easy to synthesize, having excellent electrical and optical properties, and so on [27]. On the other hand, the disadvantages of conductive polymers include a poor capacity to be processed and a low level of solubility in common solvents. Conducting polymers are good polymers

✉ Hussain A. Badran
hussain_badran@yahoo.com

[1] Department of Physics, College of Education for Pure Sciences, University of Basrah, Basrah, Iraq

[2] Ministry of Education, Directorate of Education, Al-Basma Preparatory School for Girls, Basrah, Iraq

[3] Department of Material Science, Polymer Research Centre, University of Basrah, Basrah, Iraq

Published online: 27 September 2023