

Article

Fabrication and Characterization of Eco-Friendly Thin Films as Potential Optical Absorbers for Efficient Multi-Functional Opto-(Electronic) and Solar Cell Applications

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Abstract: The necessity for reliable and efficient multifunctional optical and optoelectronic devices is always calling for the exploration of new fertile materials for this purpose. This study leverages the exploitation of dyed environmentally friendly biopolymeric thin films as a potential optical absorber in the development of multifunctional opto-(electronic) and solar cell applications. Uniform, stable thin films of dyed chitosan were prepared using a spin-coating approach. The molecular interactivity between the chitosan matrix and all the additive organic dyes was evaluated using FTIR measurements. The color variations were assessed using chromaticity (CIE) measurements. The optical properties of films were inspected using the measured UV-vis-NIR transmission and reflection spectra. The values of the energy gap and Urbach energy as well as the electronic parameters and nonlinear optical parameters of films were estimated. The prepared films were exploited for laser shielding as an attenuated laser cut-off material. In addition, the performance of the prepared thin films as an absorbing organic layer with silicon in an organic/inorganic heterojunction architecture for photosensing and solar energy conversion applicability was studied. The current-voltage relation under dark and illumination declared the suitability of this architecture in terms of responsivity and specific detectivity values for efficient light sensing applications. The suitability of such films for solar cell fabrications is due to some dyed films achieving open-circuit voltage and short-circuit current values, where Saf-dyed films achieved the highest V_{oc} (302 mV) while MV-dyed films achieved the highest J_{sc} (0.005 mA/cm²). Finally, based on all the obtained characterization results, the engineered natural cost-effective dyed films are considered potential active materials for a wide range of optical and optoelectronic applications.

Keywords: dyed chitosan thin films; laser cut-off filter; nonlinear optical parameters; heterojunction photosensors; solar energy conversion



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1. Introduction

Despite the dependence of global economic growth on rapid industrial development supported by continuous experimental and laboratory research results, global public awareness has ignored the negative effects and hazards on the environment and human health resulting from the overreliance on fuel-based manufacturing processes of synthetic plastics. In this context, over the last few years, many countries have resorted to the exploitation of eco-friendly materials and sustainability concepts for supporting economic growth along with social requirements, in addition to tackling climate change and environmental protection. This can be achieved by replacing harmful toxic chemical materials for manufacture with eco-friendly natural materials for industry [1–3].

Ultra Thin Films For Opto Electronic Applications

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Ultra-thin Films for Optoelectronic Applications Naoya Ogata, Chitose inst of science and technology (Japan), 1999
Optically active poly thiophene with a high regioregularity was synthesized for the first time by using a Rieke zerovalent zinc catalysts Head to Tail Poly 3,2,5-methylbutoxy ethylthiophene HT P S MBET was an optically active polymer with more than 93% of the Head to Tail linkages For comparison purposes regiorandom R P S MBET and achiral HT P MBET were also synthesized They are fully characterized by using proton and carbon 13 NMR spectroscopies optical rotatory power measurements circular dichroism gel permeation chromatography and UV Vis spectroscopy Both electrical conductivities and third order optical nonlinearities were measured in order to examine opto electronic properties of these ultra thin films It was suggested that electrical and optical properties were little affected by chirality Anisotropies of electrical conductivity for HT P S MBET SA mixed LB films were in close agreement with results of structural analyses The electrical and optical properties of HT P S MBET SA LB films were superior to those of spin coated films From these results it was concluded that the regioregular poly thiophene s enhanced opto electronic properties owing to the extended conjugation length of main polymer chains

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