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Vanadium Chloride Impregnated Polyvinyl Alcohol Composite as Efficient Linear, Non-Linear, and Limiting Optical Applications: Microstructure, Electrical, and Optical Properties

© H. El Hosiny Ali[1,2,3], Y. Khairy[3], I.S. Yahia[1,2,4], D.A. Nasrallah[3]

[1] Advanced Functional Materials & Optoelectronic Laboratory (AFMOL), Department of Physics, Faculty of Science, King Khalid University,
P.O. Box 9004, Abha, Saudi Arabia
[2] Researh Center for Advanced Materials Science (RCAMS), King Khalid University,
Abha 61413, P.O. Box 9004, Saudia Arabia
[3] Physics Department, Faculty of Science, Zagazig University,
44519, Zagazig, Egypt
[4] Nanoscience laboratory for environmental and biomedical applications (NLEBA), Semiconductor Lab.,
Physics Department, Faculty of Education, Ain Shams University,
Cairo, Egypt

E-mail: hithamph@gmail.com

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In this research, the solution casting technique has been used to synthesize composite with different weights of VCl_3 embedded in polyvinyl alcohol (PVA), in the form of films. X-ray diffraction (XRD) patterns display a broad peak with low intensity of high doping composite films, reflecting an increase in the non-crystallinity and the internal strain. The complex formation between the OH^- groups and the V^{3+} ions has been outlined through Fourier transform IR spectroscopy (FTIR). The film's surface morphology via SEM images shows an increase in the agglomeration with the doping ratio of VCl_3. The optical band gap and the width of localized states were changed from 4.86 to 3.03 eV and 0.85 to 2.54 eV. The average refractive index was estimated from band gap energy, as it increased to 2.46 for a composite of high doping ratio (VPVA6). Moreover, the optical susceptibilities $\chi^{(1)}$ & $\chi^{(3)}$ and the non-linear refractive index $n^{(2)}$ values indicate the possibility of applying this novel composite material on a wide scale of optoelectronic applications. The samples have reduced the power of the two lasers (632.8 and 532 nm) to 25% and 21%. The AC electrical conductivity was increased with doping ratio, and its relation with frequency is following Jounscher's law. The improved characteristics, optical performance, and low band gap make them promising in UV-protector and linear/non-linear optoelectronic instruments.

Keywords: flexible V^{3+}-doped PVA films, XRD/FTIR, SEM, optical limiting, non-linear optical properties, dielectric and electrical conductivity.