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RESEARCH ARTICLE

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Synthesis, optical nonlinear properties, and all-optical switching of curcumin analogues

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Abstract

The curcumin analogues (Cur-MeS and Cur-MeO) are synthesized using the 3-chloroacetyl acetone and aromatic aldehydes reaction. Both compounds are characterized using FTIR, LC-MS, ^{1}H NMR, and ^{13}C NMR spectroscopies. The geometric optimization and thermodynamic properties of the two compounds are carried out theoretically using DFT. The highest HOMO, lowest LUMO, and Mullikan atom charges of the two compounds are calculated using the B3LYP and CAM-B3LYP methods which are hybrid functionals with a 6-311+G(2d,p) as the basis set. The nonlinear optical (NLO) properties of both compounds are studied using the spatial self-phase modulation (SSPM) through the diffraction ring patterns (DRPs) and the *Z*-scan techniques, using a continuous wave (cw) low power 473 nm laser beam. The index of nonlinear refraction (INR) of both compounds is calculated by the two techniques. The all-optical switching property of both samples is tested using two visible cw laser beams.

KEYWORDS

all-optical switching, curcumin analogues, DFT, *Z*-scan

1 | INTRODUCTION

During the last three decades, there has been great needs for materials with high optical nonlinearities and fast response times which can be used with low power laser beams,[1–10] in variety of applications such as optical switching,[11,12] imaging processing,[13] data storage,[14–17] phase conjugation,[18] and optical limiting.[19–25]

When a laser beam with fundamental, TEM_{00}, transverse mode and continuous wave (cw) traverses a material, an intensity-dependent refraction index can be observed in the medium. The refraction index change of a medium can be determined via the spatial self-phase modulation (SSPM) due to the intensity-dependent refractive index that has been observed since 1967 in so many materials in the shape of diffraction ring patterns (DRPs) and the *Z*-scan techniques. Owing to the first technique, the total refractive index change and the index of nonlinear refraction (INR) of the medium can be determined using the total number of rings. The *Z*-scan is an effective and simple technique that was pioneered by Sheik-Bahae et al.,[26] usually used to determine the INR and absorption nonlinear coefficient (ANC), the sign of the INR, real and imaginary parts of the nonlinear susceptibility, and so on. In the *Z*-scan, self-focusing (SF) or self-defocusing (SDF) leads to a valley succeeded by a peak or a peak succeeded by a valley respectively in the relations between the normalized transmittance of the laser beam versus the sample cell position *Z*-scan.

