UNIVERSITI TEKNOLOGI MARA

OPTICAL BISTABILITY IN FERROELECTRICS VIA TWO WAVE MIXING

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ABSTRACT

Optical bistability (OB) is the phenomenon resulted from the interaction of the light source with the third order nonlinear material. OB is believed to have promising applications as basic elements for future optical computers and optical switches. In the recent years, obtaining the OB via wave mixing process attracted significant interest due to the influences of wave interaction that occurring inside the material may enhance the OB characteristic. This study investigates the OB resulting from a degenerate two-wave mixing (TWM) process in a single layer of Kerr nonlinear ferroelectric material. The nonlinear process is mathematically described by a nonlinear coupled-wave (CW) equations propagating across the ferroelectric. In the first part, we investigate the influence of the Slowly Varying Envelope Approximation (SVEA) on the evolution of the system. The results obtained in this section are compared with the standard available experimental data. Our results from this part clearly demonstrate that the full mathematical model without SVEA is essential to produce a theoretical result that is matched the experimental data as a evident in this thesis. In the second part of this work, we have examined the effect of Self Action nonlinearity on resulting OB. Self Action nonlinearity usually ignored in studying the OB via TWM. Our results show that the Self Action nonlinearity is important to detect the nonlinear response of the OB for several combinations of input parameters.

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CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

Nonlinear optics is the division of optics that deals with various kinds of nonlinear optical phenomenon occurs in nonlinear materials or optical fibers. These nonlinear optical phenomena give rise to several useful photonics applications. Nonlinear optics typically involves interactions of high intensity light with matter. This is because with the presence of high intensity light, optical properties of the material are subsequently modified, which resulted in the occurrence of the nonlinear optical phenomena. Nonlinear responses happened when the incident field is not negligible in comparison with the internal field that binds together the electrons and ions. Nonlinear optics became the area of interest beginning in 1961 when Peter Franken *et. al* have made a discovery of the Second Harmonic Generation [1].

Apart from using a high intensity light beam, another important component to observe nonlinearity is by using the nonlinear medium. These nonlinear media responded to the applied optical field in a nonlinear manner depending on the strength of the applied optical field. For example, in second order nonlinearity, the second harmonic generation is resulted from the quadratic responses of the material system [2]. In nonlinear media, the polarization reacts nonlinearly to the field strength, E of the applied optical field. Theoretically, the total polarization is expanded as Taylor's series are in terms of electric field. Each of these terms represent different and unique nonlinear optical phenomenon [3]. The second-order term in Taylor's series represents the second-order nonlinear phenomenon while the third-order term represents the third-order nonlinear response of the material. Since this field of nonlinear optics was discovered, the second and the third order nonlinear optical effects are the main focus of researchers. Among the important second order nonlinear phenomena are; Second-Harmonic Generation (SHG), Sum-Frequency Generation (SFG) and Optical Parametric Oscillation. Meanwhile, among the most important third-order nonlinear phenomena are; Third-Harmonic Generation (THG), Intensity-Dependent Refractive Index and Saturable Absorption. Each can be further analyzed by having a system that