THE STEADY-STATE AND TRANSIENT CHARACTERISTIC ANALYSIS OF THERMAL FIXING A PHOTOREFRACTIVE HOLOGRAM GRATING IN LITHIUM NIOBATE

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ABSTRACT: *The transient interaction between a refraction index grating and light beams during simultaneous writing and thermal fixing of a photorefractive hologram is investigated. With a diffusion- and photovoltaic-dominated carrier transport mechanism and carrier thermal activation (temperature dependent) considered in Fe:$LiNbO_3$ crystal, from the standpoint of field–material coupling, the theoretical thermal fixing time and the space-charge field buildup, spatial distribution, and temperature dependence are given numerically by combining the band transport model with mobile ions with the coupled-wave equation.* © 1999 John Wiley & Sons, Inc. Microwave Opt Technol Lett 23: 372–376, 1999.

Key words: *simultaneous writing/fixing; numeric solution; Fe:$LiNbO_3$*

1. INTRODUCTION

A volume hologram can be recorded in photorefractive material by two-wave mixing a redistributing charge carrier. The space-charge fields build up and modulate the refractive index via an electro-optic effect. To avoid the readout light redistributed charge carrier, heating the crystal up to 100–200°C to copy the carrier charge pattern to the thermal mobile ions pattern, which is insensitive to illumination at room temperature, is necessary.

Because of the potential and promising prospect for use as a PROM, the thermal fixing process and the role of various ions in $LiNbO_3$ photorefractive crystal were studied extensively, with the intention to obtain high diffraction efficiency. In previous research, only steady diffraction from a uniform [1, 2] or nonuniform [3] fixed grating (not necessary by thermal fixing) was considered; the band transport model and the coupling-wave equations were treated separately. Jeganathan and Hesselink [4] and Heaton and Solymar [5] have analyzed the dynamic photorefractive hologram grating (with or without the thermal mobile ion considered) by combining the band transport model with the coupling-wave equations; however, the photovoltaic effect was omitted. But in a factual case with the absence of an external applied charge field, the photovoltaic contribution to the electron transport process is

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region W. The effect of the dimensions W_s and H is practically negligible [Fig. 3(c)]. A variation of the dimension W with respect to its nominal value, according to whether an increase or decrease can be advantageous or disadvantageous, since it must be remembered that a phase velocity in practice is constant over the full frequency band, is desirable. A similar behavior is obtained for the interaction impedance K, even if, in this case, it is sensitive to the variation of all of the three dimensions of the T-shaped rod.

From the point of view of TWT operation, the effect on the phase velocity is interesting since only one dimension affects this quantity.

CONCLUSION

A study on the effect of the mechanical tolerance of a T-shaped rod on the normalized phase velocity and interaction impedance of a helix slow-wave structure in a TWT has been presented. A slow-wave structure was realized, and a comparison with experimental data has been presented. It has been shown that only one dimension significantly affects the flatness of the normalized phase velocity, a quantity particularly critical for the electrical performance of the helix slow-wave structure.

REFERENCES

1. J.R. Pierce, Traveling wave tubes, Van Nostrand, New York, 1950.
2. P.K. Jain and B.N. Basu, The inhomogeneous dielectric loading effects of practical helix supports on the interaction impedance of the slow wave structure of a TWT, IEEE Trans Electron Devices 44 (1997), 1158–1168.
3. S. D'Agostino, F. Emma, and C. Paoloni, Accurate analysis of helix slow wave structures, IEEE Trans Electron Devices 45 (1998), 1605–1613.

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