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(54) **MOBILE CHARGE INDUCED PERIODIC POLING AND DEVICE**

7,413,635 B2 * 8/2008 Essaian 204/164

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(51) **Int. Cl.**
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(52) **U.S. Cl.** **359/326; 359/332**

(58) **Field of Classification Search** **385/326-332, 385/122; 372/21-22**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,436,758 A * 7/1995 Agostinelli et al. 359/332
7,112,263 B2 9/2006 Nihei
7,236,674 B2 * 6/2007 Mizuuchi et al. 385/130

OTHER PUBLICATIONS

Muller et al., "Influence of ultraviolet illumination on the poling characteristics of lithium niobate crystals", Applied Physics Letters, Sep. 2003, vol. 38, No. 9, pp. 1824-1825.

International Search Report and the Written Opinion of the International Searching Authority for PCT/US2006/038136, Mar. 2008.

Bryan et al. "Increased optical damage resistance in Lithium Niobate" Appl. Phys. Lett. vol. 44, pp.847-849, 1984.

Dierolf et al. "Direct write method for domain inversion patterns in LiNbO3", Apl Phys Lett vol. 84 No. 20 pp. 3987-3989, 2004.

Fujimura et al "Fabrication of domain inverted gratings in MgO:LiNbO3 by applying voltage under ultraviolet irradiation through photomask at room temperature", Elect Lett vol. 39, No. 9 p. 719-721, 2003.

(Continued)

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(57) **ABSTRACT**

Devices and methods are disclosed for realizing a high quality bulk domain grating structure utilizing mobile charges that are generated by means of photo-excitation in a substrate. An effect of light exposure (UV, visible, or a combination of wavelengths) is to generate photo-induced charges. The application of a voltage across the substrate combined with the application of light exposure causes a photo-induced current to flow through the substrate. The photo-induced charges (behaving like virtual electrode inside the material) and the photo-induced current result in both reduction of the coercive field required for domain inversion in the material and improve realization of the domain inversion pattern, which previously has not been possible at room temperature.

56 Claims, 20 Drawing Sheets

