DOMAIN ENGINEERED FERROELECTRIC OPTICAL RADIATION DETECTOR HAVING MULTIPLE DOMAIN REGIONS FOR ACOUSTIC DAMPENING

REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. provisional application Ser. No. 60/036,409 filed Jan. 31, 1997, and is a continuation-in-part of U.S. patent application Ser. No. 09/016,561 filed Jan. 30, 1998, now U.S. Pat. No. 6,114,698, and U.S. patent application Ser. No. 09/655,154 filed Sep. 5, 2000.

BACKGROUND OF THE INVENTION

a. Field of the Invention

The present invention pertains generally to pyroelectric optical radiation detection, and more particularly to pyroelectric detectors constructed from a single electret in which the spontaneous polarization is selectively reversed to optimize acoustic nulling and/or modify spatial responsivity to enable position sensing.

b. Description of the Background

In the past, attempts have been made to reduce the unwanted microphonic signal in pyroelectric detectors by mechanical design, electrical design, or both. One such mechanical design places the electret on a platform optimized for dampening microphonic resonances. A platform, however, is not optimum because the low-frequency response of an electret of nonuniform thickness and/or heat sink conditions will not be spatially uniform. The simplest electrical design uses two identical electrets having opposite polarizations that are connected so that the effects of acoustic noise are cancelled. Multiple electrode schemes have been used on a single electret to reject microphonic signals. Domain engineering techniques have also been used. Domain engineering techniques in materials such as $LiTaO_3$ have required the use of an ion mill. This has resulted in very small, fragile detectors. Domain engineering in polymers such as polyvinyladine flouride has also been used, but such detectors do not have the same pyroelectric coefficient as those made from $LiNbO_3$ and $LiTaO_3$. They also result in detectors that do not have a highly uniform thickness. Acoustic ringing can also result from the deformation of the electret as a result of sound or pressure waves, the impingement of a pulsed laser, and other sources of noise. High frequency pulsed lasers may also create acoustic waves that cause the thickness of the electret to vary, creating additional acoustic resonances. The acoustic ringing and resonances may take the form of standing or traveling waves in the electret.

It would therefore be advantageous to provide a single pyroelectric detector that provides acoustic nulling, beam detection and dampening of acoustic ringing and acoustic resonances.

SUMMARY OF THE INVENTION

The present invention overcomes the disadvantages and limitations of the prior art by providing a single pyroelectric detector that is capable of providing acoustic nulling, beam location detection and dampening of acoustic ringing and acoustic resonances. This is accomplished by using a single crystal that has reversed domain polarization regions. Acoustic nulling is provided by combining the outputs of the reversed domain polarization regions. Optical beam detection and location of the optical beam on the electret can then

be realized as a result of the pyroelectric effects of the electret as opposed to the piezoelectric effects of acoustic noise. The reversed domain regions can be placed in a periodic pattern that is related to the speed at which the acoustic noise travels through the electret to allow nulling of standing or traveling waves. Additionally, acoustic noise is physically dissipated and scattered by the introduction of multiple domain regions that further reduces acoustic ringing. For example, the introduction of needle domains functions to scatter and dissipate acoustic waves in the electret.

The present invention may therefore comprise a method of reducing acoustic noise in a pyroelectric detector formed from a z-cut single crystal electret comprising: generating a plurality of domain regions in the electret having opposite polarization directions, the domain regions having a periodic pattern that substantially corresponds to wave patterns of acoustic noise; providing an electrode that covers approximately equal portions of the plurality of domain regions, so that charges generated by the plurality of domain regions in response to acoustic noise can be combined to substantially null the acoustic noise.

The present invention may further comprise the method of constructing a pyroelectric detector from a z-cut single crystal electret comprising: generating a first domain region in the electret having a first polarization; generating a plurality of needle domain regions having a polarization which is opposite to the first predetermined polarization.

The present invention may further comprise the method of constructing a multicell pyroelectric detector formed from a z-cut single crystal electret for detecting the position of a light beam comprising: generating at least two domain regions in a central portion of the electret having opposite polarizations; generating a plurality of needle domain regions surrounding the central portion of the electret.

The present invention may further comprise the method of forming a plurality of bicell pyroelectric detectors using a shadow mask comprising: providing a z-cut single crystal electret having a spontaneous polarization in a first direction; placing a shadow mask on the electret that has openings that correspond to the regions in which a polarization is desired that is opposite to the spontaneous polarization of the electret; depositing a poling electrode on the electret in the areas of the openings of the shadow mask; using the poling electrodes to polarize the electret with the opposite polarization; removing the poling electrodes; dividing up the electret to form the plurality of multicell pyroelectric detectors.

The present invention may further comprise a multicell pyroelectric detector formed by the method of: providing a z-cut single crystal electret having a spontaneous polarization in a first direction; placing a shadow mask on the electret that has openings that correspond to the regions in which a polarization is desired that is opposite to the spontaneous polarization of the electret; depositing a poling electrode on the electret in the areas of the openings of the shadow mask; using the poling electrodes to polarize the electret with the opposite polarization; removing the poling electrodes; dividing up the electret to form the plurality of multicell pyroelectric detectors.

The present invention may further comprise a pyroelectric detector formed from a z-cut single crystal electret comprising: a central portion of the electret; a plurality of domain regions surrounding the central portion the plurality of domain regions having opposite polarization directions, the plurality of domain regions having a periodic pattern that substantially corresponds to wave patterns of acoustic noise