Switching Mode Infrared Pyroelectric Detection for Focal Plane Arrays

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ABSTRACT

This paper describes an active mode pyroelectric sensor that employs a strontium bismuth tantalate ($SrBi_2Ta_2O_9$ or SBT) ferroelectric thin film. The device operation is based on the use of the switching properties of ferroelectric material combined with infrared (IR) detection. This switching mode of IR detection results in improved signal to noise ratio, an enhanced effective pyroelectric coefficient, and the elimination of mechanical chopper devices that are used in most passive or non-switching pyroelectric sensors. In addition to having a comparatively high thermal responsivity in the medium and long wavelength infrared radiation bands and a high endurance, this pyroelectric sensor enables selective wavelength response tuning by controlling the thickness of the insulating layer and the absorber material, thus maximizing the device responsivity to a particular wavelength band. The thermal and electrical performance characteristics of a single SBT sensor using the switching mode technique has demonstrated that this sensor is potentially a high sensitivity and low noise-equivalent temperature difference (NETD) device that could be used in the development of focal plane arrays (FPA). This work also contains a theoretical model of the pyroelectric detection in the active mode and auxiliary circuits that convert measured radiation to useful electrical signal. This paper also shows the calibration procedures and a preliminary array that can use this IR sensor. As part of the complete sensor evaluation, this paper also presents thermal analysis of a novel multilayer substrate that eliminates the need for MEMS isolation.