www.DeepakPublishing.com

Shobha, V. et al. (2017): JoSS, Vol. 6, No. 2, pp. 581–590
(Peer-reviewed article available at www.jossonline.com)

www. JoSSonline.com

Investigation of Gamma and High Energy Electron Dose Effect on a MOEM Sun Sensor Developed for Micro Satellite Applications

S. P. Karanth, V. Shobha, Sumesh M. A., T. V. Sridevi, K. T. Manjunath, Beno Thomas, L. V. Prasad, M. Viswanathan

Laboratory for Electro-Optics Systems (LEOS)
First Phase, First Cross, Peenya Industrial Estate
Bengaluru, Karnataka, India

Abstract

High accuracy micro sun sensors (i.e., with angular resolution better than 0.1°) for space applications are designed and developed using n^+/p junction twin triangular silicon photo detectors (planar process) anodically bonded with micro-optics (Corning 7740) that have an etch cavity depth of around 100 μm on one side and a 300 μm wide slit patterned on high optical density black chrome on the other side. This sensor configuration determines sun angle by taking differential current outputs from the individual photo-detectors. The normalization technique adopted makes the output independent of flux variations, ambient temperature fluctuations, and cosine effect of incidence. Micro sun sensor devices, for which field of view is around ±50°, are characterized for sensor performance, including mainly sensitivity and non-linearity in the linear range of ±25°. Achieved sensitivity and non-linearity of these devices are 140 mV/deg and better than 10%, respectively. In addition, the effect of gamma and electron irradiation on the sensor's performance was studied. Two devices were subjected to gamma radiation (dose = 100 krad), with a rate of 23 *rad/s* using *Co-60* source, with a finding of no gamma radiation effect on sensor voltage output. Post-sensor performance evaluation of the two devices that underwent electron irradiation of energy 8–10 MeV with a fluence of $2\times10^{13}/cm^2$ revealed that sun presence, non-linearity, and sensitivity are varied. The high energy particle irradiation effect was studied with the help of analytical models, and variation was substantiated quantitatively.

1. Introduction

Sun sensors are used in the control and determination of spacecraft attitude. The Laboratory for Electro-Optics Systems (LEOS) has initiated activity to use a micro-electro-mechanical (MEMS) fabrication route combined with planar silicon processing technology for the development of high accuracy, low mass, low volume, miniaturized sun sensors (i.e., micro sun sen-

Corresponding Author: V. Shobha, v_shobha@leos.gov.in
Publication History: Submitted – 11/30/16; Revision Accepted – 05/23/17; Published – 08/28/17