Revised Intro, FM

EE, 20182327

Lee Jong Geon

Tilted deep trench isolation structure to maximize quantum efficiency of a CMOS image sensor at the corner of an image sensor chip

Jong Geon Leea, Dong Hyeon Leea, Jin Ha Lima, Hae Wook Hana,⁎

*a Department of Electrical Engineering, Pohang University of Science and Technology, San 31 Hyoja Dong, Pohang, Kyungpook 790-784, Republic of Korea*

***Abstract---*We attempted to maximize Quantum Efficiency (QE) in CMOS Image Sensor (CIS) which is used in image sensor chips. In the Finite Differential Time Domain (FDTD) simulation, we shifted Color Filter (CF) and Micro Lens (ML), and tilted Deep-Trench-Isolation (DTI). We increased QE 3.80 %p in red, 4.70 %p in green, 0.30 %p in blue, and 2.70 %p in white. Also we decreased crosstalk (X-talk) 0.05 %p in red, 0.20 %p in green, and 0.10 %p in blue.** **The tilted DTI CIS can get clearer images than the shifted CIS at the corner of an image sensor chip.**

**Index Terms---CMOS Image Sensor (CIS), deep trench isolation (DTI)**

1. **Introduction**

C

MOS Image Sensor (CIS) is used to camera image sensor. CIS has low power consumption and high readout speeds than CCD on smartphone and digital camera [1]. However, CIS has low Quantum Efficiency (QE) and crosstalk (X-talk) ratio than CCD [2]. Therefore, we should increase QE of CIS. Usually, QE was varied by CIS structure. Several structure already introduced [3] [4] [5].

Also, QE vary among the distance from center of an image sensor chip. At the corner of a chip, the light propagate obliquely [6]. Therefore, the light was detected little than the center of a chip because of scattering. Different QE detection on the same chip causes irregular brightness or resolution in an image. One solution is to shift the CIS; this change causes the light to spread smoothly to the detection region. However, a shifted CIS still has low QE and high X-talk than normal CIS.

The tilting angle of Deep-Trench-Isolation (DTI) affects QE. Therefore, a tilted DTI CIS which can increase QE than shifted CIS. The tilted DTI CIS structure optimized by Finite-Differential Time Domain (FDTD) simulation with varying horizontality shifting distance of Micro Lens (ML), Color Filter (CF) and tilted angle of DTI.

Reference

[1] Teledynedalsa.com. (2018). CCD vs CMOS | Teledyne DALSA. [online] Available at: https://www.teledynedalsa.com/en/learn/knowledge-center/ccd-vs-cmos/ [Accessed 15 Jul. 2018].

[2] “CCD vs. CMOS, sensitivity in low light improvements with industrial CMOS image sensors and cameras – Adimec,” Adimec, 11-Apr-2018. [Online]. Available: https://www.adimec.com/ccd-vs-cmos-sensitivity-in-low-light-improvements-with-industrial-cmos-image-sensors-and-cameras/. [Accessed: 15-Jul-2018].

[3] C. N. Tu, Y. L. Yeh, L. I. N. Hsing-Chih, C. C. Huang, & S. S. Chen, (2017). U.S. Patent No. 9,818,779. Washington, DC: U.S. Patent and Trademark Office.

[4] C. R. Moon, D. H. Lee, & S. H. Cho, (2012). U.S. Patent No. 8,164,126. Washington, DC: U.S. Patent and Trademark Office.

[5] G. Agranov, V. Berezin, & R. H. Tsai, (2003). Crosstalk and microlens study in a color CMOS image sensor. IEEE Transactions on Electron Devices, 50(1), 4-11.

[6] “CMOS sensor CRA,” *DPReview*. [Online]. Available: https://www.dpreview.com/forums/thread/3819663. [Accessed: 15-Jul-2018].