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2012

Development of Stacked CMOS Image Sensor (Sony)

~ Discrete Semiconductor/Others ~

In a CMOS image sensor for mobile phones typified by smartphones, a back-illuminated sensor was developed which realized image quality improvement of miniaturized pixels, which was capable of efficiently taking light from the back side without being disturbed by metal wiring, and it became possible to take clear images even in the dark by improving the sensitivity and achieving high SN ratio. Since light is captured from the backside of silicon, a sensor thinning process is necessary, and a supporting substrate that supplements the mechanical strength is used.

In recent years, not only the improvement of image quality as a camera, but also addition of new functions, high speed and low power consumption are always required, and it is essential to improve the performance of the logic circuit, to realize lower power consumption, and to take in the most advanced technology generation. However, it is difficult to develop sensor technologies that is compatible with logic device integrating on the same silicon substrate while maintaining high image quality characteristics of pixels.
Therefore, by using a process in which pixels and logic were optimized on separate substrates, a logic circuit substrate was used to stack pixel chip three-dimensionally on it in place of a back-illuminated supporting substrate. TSV (Through Silicon Via) was used for the multipoint electrical connection of the top and bottom chips.

Advantages and features of this 3D stacked CMOS image sensor are as follows.
(1) Maximum performance realized by process optimization of pixel and logic circuit independently.
(2) Realization of new camera functions on one chip by an increase in circuit integration of logic chip.
(3) Expansion of production volume due to chip size reduction (30 to 40% reduction compared to the past)

By improving the pixel performance and logic circuit function of this stacked CMOS image sensor, it became possible to create new functions such as "high dynamic range (HDR) movie" which could shoot vivid colors even with backlight, and recently installing the image-plane-phase-difference AF signal processing function with excellent focus tracking capability. And further improvement of image quality has been realized by this stacked CMOS image sensor technology.
As means to realize high function and high image quality, the stacked CMOS image sensor has become a new trend in the industry following back-illuminated type. In addition, it is a product realizing a new business model from the viewpoint of production scale that mass production is carried out for consumer products in the three-dimensional stacked semiconductor field.

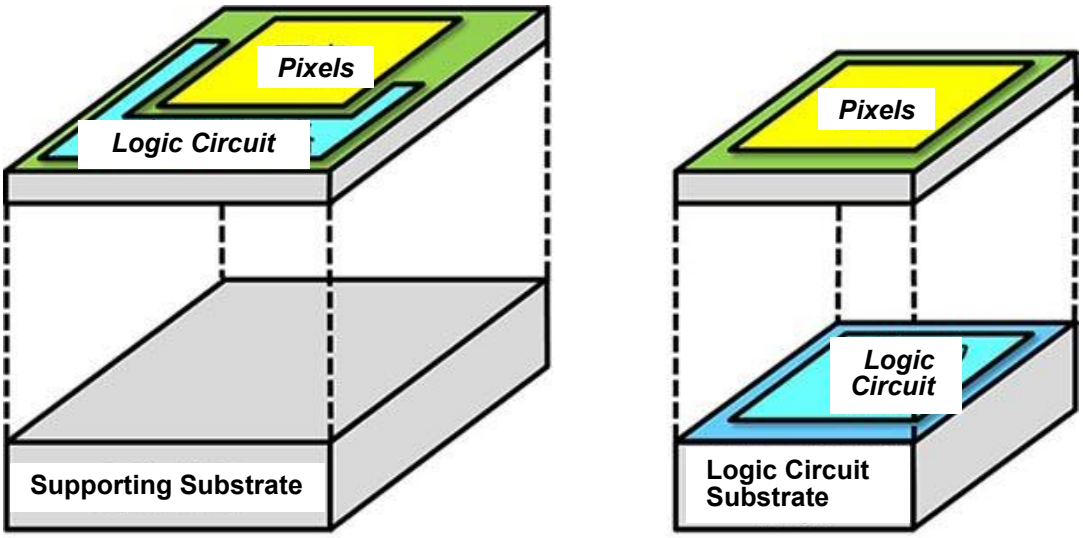

Fig.1: Conceptual diagram and sectional view of stacked image sensor

Image without “HDR movie” function　　Image with “HDR movie” function

Fig.2: Example of capturing an HDR movie
(By courtesy of Sony)

References:

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[2] Taku Umebayashi,” 3D Stacked CMOS Image Sensor Exmor RSTM”, ISSCC 2014 Forum F2
[3] Tomoharu Ogita,” Technology and overview of Sony's 3D stacked CMOS image sensor”, 3DIC 2015 International TS9.1.1

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