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# The Design of Metal-Semiconductor-Metal Structure Magnetic sensor

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## Abstract

This paper presents the MSM structure magnetic detector device that normally detects the electromagnetic wave. The device is special design for magnetic field detector and still detects the electromagnetic wave as normal function. The schottky diode with the split contacts structure allows us to reach this target. The device operates with the saturation current and the magnetic response is the current difference between two contacts which is injected from one metal and deflected in semiconductor toward to another metal. From the simulation result by Sentaurus TCAD, the relative sensitivity is  $14.19 \text{ mT}^{-1}$  at the current  $0.3 \mu\text{A}$ . This device is the first MSM multi-sensor for magnetic and electromagnetic wave detector.

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## 1. Introduction and Structure

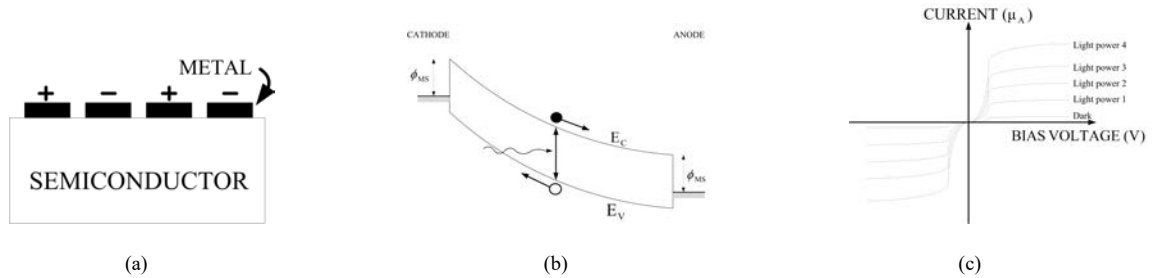
MSM is the structure of electromagnetic detector device that composes of two schottky junction connected back to back together as metal semiconductor metal [1]. This structure is simple and low cost but shows very low

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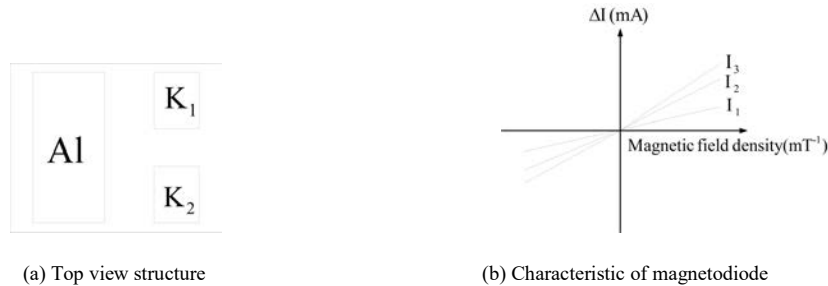
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capacitance. The structure is normally designed in interdigitated structure for high sensitivity rather than rectangular or square large area. The photo current generate from the junction area under the metal and the gap between metals [2]. The bias can be applied between two metals that one junction is forward and another is reverse. The interdigitated structure, energy band diagram through the active layer and photo current characteristic are shown in Figure 1.



**Figure 1.** MSM photo detector (a) The interdigitated structure MSM (b) Energy Band diagram (c) Photo current characteristics.

The dual magnetodiode is the device for magnetic detection [3,4]. The structure composed of two diodes that designed the suitable deflection length of carrier between the injected junction to contact. The anodes are commoned and two cathodes are separated. When magnetic field is applied, the induced force from magnetic field vector cross the current vector act upon the injected carriers along the deflection length so the current of two cathodes are difference  $\Delta I$ . The current difference depend linearly on the magnetic field density and the sign of  $\Delta I$  is inversion when the direction of magnetic field is opposite. The diode can be fabricated as pn junction as well as schottky junction. The device can operate in forward and reverse bias and can be done both in hole and electron injected currents. Figure 2. shows the structure of dual magnetodiode and the characteristics.



**Figure 2.** Dual magnetodiode.

The MSM multi-sensor structure can be designed to reach this purpose because of the dual magnetodiode structure. It is the merged structure between the MSM photo detector and magnetodiode. The core of the structure is the junction so the schottky junction between metal-semiconductor is selected here rather than pn junction of magnetodiode. The metal area must use for photo absorbtion and for magnetic response so the rectangular or square shape of metal is designed. The gap between metals is defined as deflection length in the same time so the critical length is determind by the length of carrier deflection. The current difference of magnetic response is carried out by fabricated the two contact windows  $W_1$  and  $W_2$  within the metal for connecting with the other metal contact layer for two separated current response. This structure is shown in Figure 3(a) and the 2-dimensions model for simulation by Sentaurus TCAD program is shown in Figure 3(b). The area of metals are  $400 \times 400 \mu\text{m}^2$  with the contact window  $50 \times 50 \mu\text{m}^2$  and the gap between metals and contacts are  $100 \mu\text{m}$  and  $10 \mu\text{m}$ , respectively.

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