Electrical characteristics of a new Ni-MPS rectifier

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The power semiconductor industry requires low-loss devices and highly efficient rectifiers for many application, such as automotive electronics, motor control in traction, and power supplies[1]. At generally high-voltage systems, the silicon P^+iN rectifiers are commercially used. It can be withstand over 100 V reverse bias. At relative low-voltage systems, Schottky junction rectifiers can be used. The advantage of the P^+iN and the Schottky rectifiers is high-break down voltage, low-forward voltage drop, respectively. The MPS (merged P^+iN Schottky) rectifier that is based upon integration of Schottky contact region with silicon P^+iN junction grid structure has above advantages. So, we have investigated the electrical characteristics of the new nickel-MPS (Ni-MPS) rectifiers.

Table 1 shows the design rule for fabrication of MPS rectifier with three and four P^+iN junction areas. The size of the device described here is 2.6 ㎜×2.6 ㎜. The calculation of the percentages Schottky junction area in table 1 is [(Schottky area)/(Schottky area + P^+iN junction area)]×100 [%]. This area is the important factor to determine forward and reverse characteristics.

The investigated structure of the Ni-MPS (nickel-MPS) rectifier with 70 % Schottky junction area is shown in Fig. 1. The J_F-V_F characteristics of the Ni-MPS rectifier are shown in Fig. 2. In the same current level, experimental results show that the forward voltage drops (V_F) of the Ni-MPS rectifier are the lower than that of the Al-MPS rectifier. The difference of V_F is due to difference of barrier height. In our experiment, the barrier height of the Schottky contact has been measured from forward current-voltage (I-V) curve of the schottky junction. The calculated barrier height of the Ni-MPS rectifier and the Al-MPS rectifier is 0.66 V, 0.76 V, respectively. Generally, the power loss of the rectifiers dominantly depends upon the forward current density (J_F) and the V_F. Therefore, the Ni-MPS rectifier could achieve the improved power loss characteristics when compared with the conventional Al-MPS rectifier.

The reverse breakdown characteristic of a Ni-MPS rectifier is shown in Fig. 3. It was found that the reverse breakdown voltage (V_{BR}), at 70 % Schottky junction area, was about 300 V. These breakdown voltage is the higher than that of conventional MPS rectifier. This new Mo-MPS rectifier exhibits a superior performance such as lower power loss than conventional Al-MPS rectifier. Consequently, we could find that the new Ni-MPS rectifier had the lower forward voltage drop and higher breakdown voltage than those of conventional Al-MPS rectifier.

Reference

1. B. J. Baliga, Power semiconductor devices, Boston, PWS, pp.153-193, 1996.
2. B. M. Wilamowski, Schottky diodes with high breakdown voltage, Solid-State Electron, Vol. 26, pp. 491-493, 1983.

Table 1. Design data of the Mo-MPS and the Al-MPS rectifiers.

Chip size (mm^2)	Schottky junction area (㎛^{2})	P^+iN junction area (㎛^{2})	P^+iN junction width (㎛)	Schottky junction area (%)
2.60×2.60	4,423,680	1,336,280	80,80,80	70
2.60×2.60	3,866,560	1,797,840	110,110,110	53
2.60×2.60	3,358,800	2,305,600	110,110,110,110	31

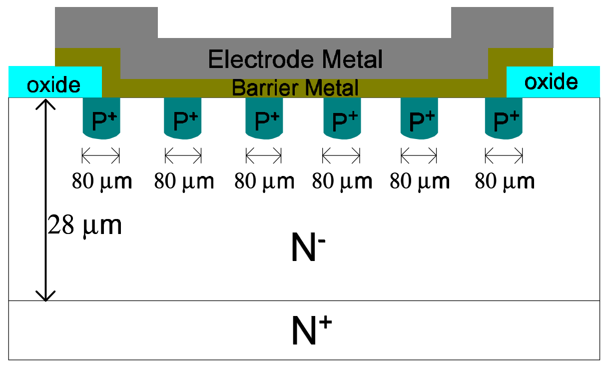

Fig. 1. Cross section of a Ni-MPS rectifier.

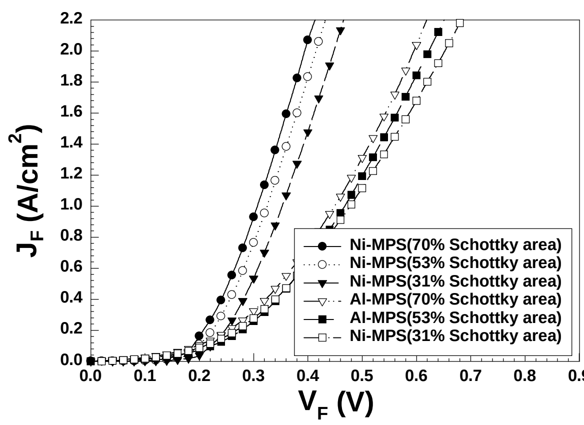

Fig. 2. Forward characteristics of the Ni-MPS and the Al-MPS rectifier with varying percentage Schottky junction area.

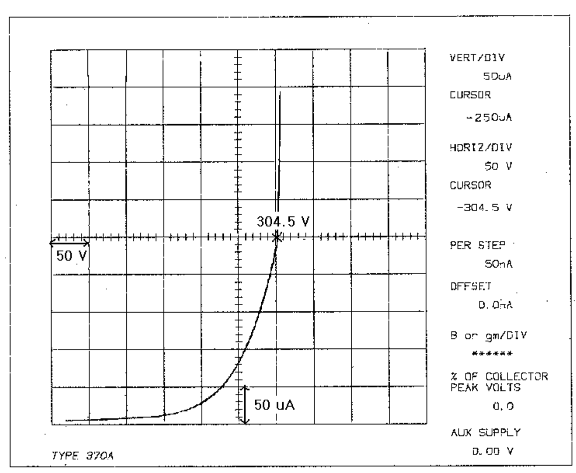

Fig. 3. The reverse breakdown characteristics of a Ni-MPS rectifier (with 70 % Schottky junction area)