Study of transition process of NV charge state in diamond Schottky barrier diode by transient photocurrent and photocapacitance

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In recent years, the research of nitrogen-vacancy (NV) centers in diamond have attracted wide attention due to its potential applications in the quantum field. The sensitive methods for NV detection in diamond devices is also necessary and important. Here, we use transient photocurrent and photocapacitance to explore the transition process of the NV center in the diamond Schottky barrier diode, identify the current and capacitance changes caused by NV photoionization. The Schottky diodes are fabricated on a CVD boron-doped diamond layer which is divided into two parts, half of the diamond film was treated with nitrogen ion implantation and annealing treatment, and the other was without.

Through exploration of the transient photocurrent under different light intensities at 700nm and 500nm, as shown in Figure 1, it is found that there is a photocurrent overshoot under the light of 700nm, and this phenomenon disappears at 500nm light. As the 700nm light intensity increases, the photocurrent overshoot becomes more obvious. Combined with the analysis of transient photocapacitance results, it is believed that this is due to the redistribution of the internal electric field caused by the rapid accumulation of electrons in the depletion layer. The reduction of the internal electric field leads to a decrease in the photocurrent. Until the defects are gradually filled, the internal electric field reaches a new equilibrium, and the photocurrent reaches a stable state. It is different under 500nm green light with high-energy photons. Previous research showed that the NV center can switch between different charge states by two-photon process. Therefore, the change in the number of electrons in the depletion layer is not significant and will not cause a rapid redistribution of the internal electric field, so the photocurrent overshoot phenomenon disappears. This result is also consistent with the photocapacitance result. Therefore, we demonstrated the photoionization of NV centers induced a change in SBDs current and capacitance, which provides us with ideas for a better and new spin detection technique.

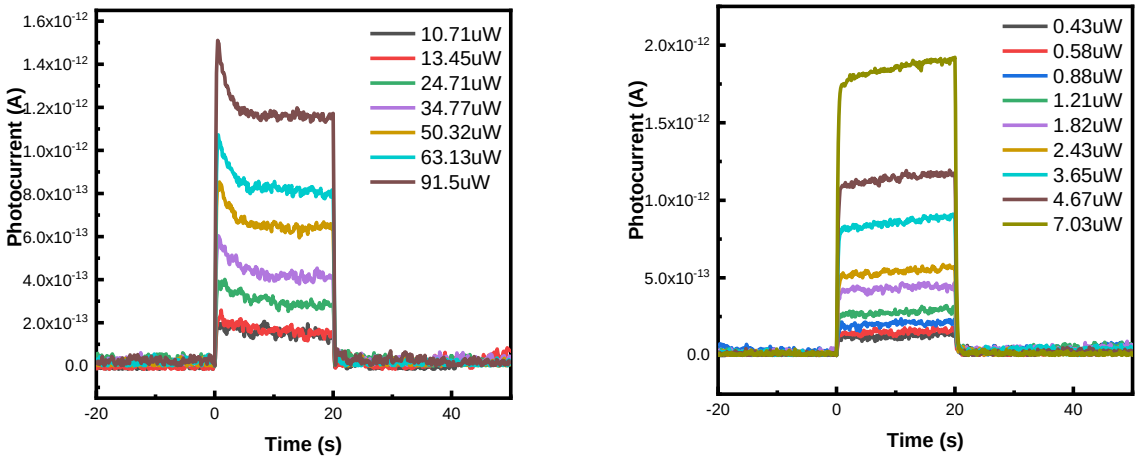

Figure 1 Transient photocurrent result under (a) 700nm (b) 500nm with different light intensity

References

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