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# Electrical Activities of Sulfur Dopants in GaAs Introduced by Self-Assembled Molecular Monolayers

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**Abstract :** The self-assembled molecular monolayer doping technique continues to attract significant research attention due to its inherent characteristics of being conformal, nondestructive, and self-limiting in nature. However, the carrying molecules may contaminate the substrate and electrically deactivate the dopants. In this work, we investigate the electrical activities of sulfur dopants in GaAs introduced by the self-assembled molecular monolayer doping technique. The sulfur dopants are then driven into GaAs to create electrical doping effect by rapid thermal annealing process. The total number of dopants diffused into GaAs is analyzed by secondary ion mass spectroscopy and source-limited diffusion model. Hall effect measurements are employed to find the electron concentration at different temperature. The temperature dependent electron concentration is fitted with the dopant activation theory, from which we extract the activation energy as 68 meV and the concentration of electrically active sulfur dopants as high as 4.4 X 1014 cm-2. We find that more than 91% of sulfur dopants in GaAs are electrically active, indicating that the impact of carrying molecules is minimal. We employ this monolayer doping technique to create a PN junction diode on a p-type GaAs substrate. The PN junction diode exhibits an outstanding performance with an ideality factor of 1.26 and a rectification ratio up to 104 within the bias of ± 0.6V.

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