Creation of spin defects in h-BN monolayer by ion implantation

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The controlled creation of single photon emitters (SPEs) in two-dimensional materials has gained significant attention due to its potential applications in quantum technologies and optoelectronic devices [1].
Hexagonal boron nitride (h-BN) is a two-dimensional layered material that is highly stable at high temperatures and resistant to chemical reactions [2]. The ability to generate defects with precise control and characterize their impact on the material properties is crucial for unlocking the full potential of h-BN in next-generation electronic devices. However, the controlled introduction of defects into h-BN monolayers remains a significant challenge [3].
This work aims to address this challenge by utilizing ion implantation as a technique to generate defects in monolayers of h-BN. The process is conducted in a high vacuum environment (10^{-8} mbar) where we focus, for now, on the creation of vacancies in an h-BN monolayer on Si/SiO_2 through argon ion bombardment with a maximum energy of 5 keV. The ion energy and dosage are carefully optimized to achieve a controlled density of vacancies while minimizing structural damage. Although the effects of irradiation on 3D systems are well-established, a mounting body of experimental evidence suggests that many concepts developed for understanding the interaction between energetic particles and solid materials in 3D systems are either not applicable to 2D materials due to their unique geometry or require significant modifications to be applicable [4].
After the ion irradiation process, the sample can be further characterized in photoluminescence (PL) on a confocal microscope [5]. By means of this technique we have been able to observe bright spots with their respective spectra in the areas bombarded with low energy ions.
While these results are promising, it is necessary to better analyze the behavior and characteristics of these possible defects, as well as their correlation with the ion energy and dose. Additionally, as future work, we plane to explore the effects of ion implantation using different gas types, such as carbon-rich gases, to explore the generation of substitution carbon defects in the h-BN monolayer.

Acknowledgments

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References

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