Photophysics of Nitrogen Vacancy centres in Nanodiamonds

Reece P. Roberts[1,2] and Author2[1,2]

[1] *Department of Physics & Astronomy, Macquarie University, NSW 2109, Australia and*

[2] *ARC Centre for Engineered Quantum Systems, Macquarie University, NSW 2109, Australia*

Abstract

I will write my abstract when I know my exact story. The paper will be two papers, one for 780nm and one for 1042nm, unless I gain by putting the two papers together and build one higher impact paper. The complete set of data should answer this question. For example is there a difference between the mechanisms for each wavelength. For example the 780nm can both ionise and recombine, however maybe the 1042nm can only ionise and can't lease to a recombination process.

INTRODUCTION

The NV^- charge state is an intensively studied material that has shown a wide range of applications in both Physics and Biology due to it's high stability and interesting optical properties. Biologists have used them extensively for biolabelling and imaging of internal biological structures (???ref3 and 4). Meanwhile, Physisits have been investigating their use in a wide range of nanoscale sensing and quantum sensing applications(???ref5). By exploiting the quantum mechanical interactions of the defects internal spin state, room temperature quantum effects can be observed in the NV^- centre providing a platform to study a wide variety of quantum manipulation protocols (???ref6). However, these desirable effects rely solely on the properties arising from the NV^- charge state and in most applications the excitation wavelength is chosen to be around 510-540nm, as this region was shown to have the highest charge state polarisation (ref7???). Despite the choice of an optimised excitation wavelength the charge state polarisation was always $\leq 75\%$.

thus the neutral NV^0 charge state is often neglected. In

NITROGEN VACANCY CENTRE

Describe in more detail the centre itself

Negatively Charge State

Describe energy transitions and details of NV-

Neutral Charged State

Similarly do the same with NV0

Ionisation Process

Desribe NV- to NV0 Process

Recombination Process

Describe NV0 to NV- Process

EXPERIMENTAL DETAILS

Describe the Quenching Experiment.

QUENCHING MODELS

In order to determine the intrinsic photophysics of our nanodiamonds we developed an 8 level rate equation model that incorporates both the ionisation and recombination mechanisms as well as the STED like mechanisms. The free paramaters of the model were varied in order to determine the most likely dynamics of the system. Four approaches were investigated and the most likely model was indetified by the Akaike information criteria blah blah

Insert simple diagram of the model and then for each model include separate rates.

Underlying assumptions and unknowns

'STED' model

Blah

Simple Ionisation and Recombination Model

Where the Ionisation and recombination rates are linearly dependant on laser power indepentant of wavelength.

Wavelength Dependant I&R

Where the Ionisation and recombination rates are linearly dependant on laser power and dependant on wavelenght.

Spin Depenatant I&R

Where the Ionisation and recombination rates are linearly dependant on laser power and dependant on wavelength. In addition there are separate ionisation rates from the $ms = \pm 1$ and $ms = 0$ of the excited NV- charge state to the ground state. However the

ratio between these two ionisation channels is held constant for each laser wavelength.

AKAIKE INFORMATION CRITERIA

Blah Blah

Highlight the optimal model, Maybe put table here or in appendix.

DISCUSSION

The optimal model is blah?

Model Parameters

The the values make sense? What are the ionisation rates like? are the close to 10ms/mW. Spin dependancy may occur from different dipolar cross section between the two excited states. Similar with the recombination rates? Link it to singlet nitrogen. Recombination occurs into which ground state of the NV- Singlet recombination between 0.66 and 1 which is consistent.

Charge state

Blah

Spin State

Blah

COMPARISON WITH OTHER WORK

Blah

CONCLUSION

Say that this indicates that this is the channels that are liekly to occur. If you want to use NV with other lasers than only the 532nm these dynamics must be understood. and then provide array of ways that could investigate these affects.

Acknowledgements

....