NV Color Center Generation *Via* fs-Laser Micromachining in CVD Diamond

L K Nolasco[1], L N S de Andrade[2], S Pratavieira[2], S R Muniz[2], and C R Mendonça[2]

[1]*Department of Materials Engineering, University of São Paulo, Av. João Dagnone, 1100, Jd Sta Angelina, São Carlos, Brazil. Contact Phone: +55 (16) 3373-6814*

[2]*São Carlos Institute of Physics, University of São Paulo, Av. Trab. São Carlense, 400, Parque Arnold Schimidt, São Carlos, Brazil. Contact Phone: +55 (16) 3373-9672*

Contact Email: lucas.konaka.nolasco@usp.br

Diamond is a well-known semiconductor that possesses extraordinary mechanical, thermal and optical properties. In addition, it also presents interesting nonlinear optical properties and can host many different defects associated with trapped electrons or holes. The Nitrogen-Vacancy color center, currently being explored for possible Quantum applications, is one of the most notorious defects present in diamonds. Femtosecond laser micromachining is a processing technique used to produce photonic devices in either the surface or volume of a material, which distinguishes itself due to its high precision (micro/nanometric) since laser ablation only occurs at the focal volume of the laser beam. Once such method can produce vacancies on the diamond crystal lattice as a byproduct of the laser damage, one can generate NV color centers in specific locations. Hence, optimal experimental conditions for the generation of such defects *via* fs-laser processing was investigated. A Yb:KGW fs-laser system was used, operating at 1030, 515 or 343 nm and producing 185 up to 1000 fs pulses at 197.5 kHz. Microstructures of 100×100 μm were fabricated on the CVD diamond's sample with a constant pulse superposition number, while the excitation fluence (J/cm^2), excitation wavelength and pulse duration were varied. We were able to determine that NV center generation is proportional to the excitation fluence and inversely proportional to the pulse duration and wavelength by analyzing confocal microscopy images when the sample was excited at 543 nm and a filter from 620 up to 700 nm was used. From such images, we measured the total area percentage of the defects for each experimental condition, and plotted such results as a function of the laser fluence for each pulse duration and wavelength used. Furthermore, a model for the defect generation *via* fs-laser excitation was proposed which corroborated the observed results. Finally, ODMR (Optically Detected Magnetic Resonance) measurements were taken to further prove the presence of NV centers in the microstructures as well as determine its longitudinal relaxation time (T_1), which was found to be 3.2 ms. Thus, this work is an important step towards mastering NV color center generation *via* femtosecond laser pulses for possible Quantum/Photonics applications.