Contribution ID: **23** Type: **Submitted oral (In person)**

Radiotracer photoluminescence and emission channeling studies of group-IV quantum emitters in diamond

Friday 29 November 2024 11:30 (12 minutes)

Colour centers based on group-IV impurities (SiV, GeV, SnV, and PbV) in diamond are intensively investigated in the context of quantum nanophotonic applications, with some of their attractive properties stemming from the inversion symmetry of their split-vacancy configuration and their high Debye-Waller factor. Whereas a significant amount of research has been devoted to study their **optical** activation yields after ion implantation and thermal annealing, very little is known about their **structural** formation yields, thermal stability and annealing mechanisms. As part of experiment IS668, we have been studying the lattice location of implanted ^{75}Ge, ^{121}Sn and ^{209}Pb in diamond, using the β^- emission channeling technique. In this talk, we review our previous work [1,2] and present new results from recent beam times, centered around three main findings: (i) contrary to general belief, the GeV, SnV and PbV defects are efficiently formed upon implantation, without the need for annealing-induced diffusion of C vacancies; (ii) while the SnV and PbV defects are stable up to 900 °C, for Ge, annealing or implanting at moderate temperatures (300 °C) significantly reduces the amount of GeV centers, suggesting the existence of two coexisting defect annealing mechanisms; (iii) contrary to recent proposals based on indirect interpretation of optical activation studies, our experiments show that electrical co-doping does not substantially affect the structural formation yields. As part of experiment IS668, we have also developed a radiotracer photoluminescence (rPL) setup specifically optimized for studying colour centers in diamond, located at the newly established **Quantum Photonics Lab** in Building 508. Radiotracer PL is specifically designed to overcome the major limitation of standard PL of not being element specific: using a radioactive isotope and recording the time dependence of the intensity of the rPL lines allows us to correlate them with the half-life of the parent or daughter isotopes. In this talk we will present the first successful rPL experiment on colour centers in diamond performed at ISOLDE, where we recorded the time dependence of GeV$^-$ zero-phonon line (ZPL) and correlated it with the decay of ^{75}Ge. We will also describe our planned rPL experiments within IS668 aimed to determine whether various PL lines observed upon implantation of Sn and Pb are indeed associated with the implanted impurities or instead result from the creation or activation of other defects and impurities.

[1] Phys. Rev. Lett. 125, 045301 (2020), U. Wahl, J.G. Correia, R. Villarreal, E. Bourgeois, M. Gulka, M. Nesládek, A. Vantomme, and L.M.C. Pereira

[2] Mater. Quantum. Technol. 4 025101 (2024), U. Wahl, J.G. Correia, A. Costa, A. Lamelas, V. Amaral, K. Johnston, G. Magchiels, S.M. Tunhuma, A. Vantomme, and L.M.C. Pereira

Author: DANILOV, K. (KU Leuven)

Co-authors: BIESMANS, B. (KU Leuven (BE)); LAMELAS, A.; TUNHUMA, S. M. (KU Leuven (BE)); COSTA, A. (Universidade de Lisboa (PT)); DAVID-BOSNE, E. (Czech Technical University in Prague (CZ)); JOHNSTON, K.; AMARAL, V. (University of Aveiro (PT)); VANTOMME, A. (KU Leuven (BE)); CORREIA, J. G. (Universidade de Lisboa (PT)); WAHL, U. (Universidade de Lisboa (PT)); PEREIRA, L. M. C. (KU Leuven (BE))

Presenter: DANILOV, K. (KU Leuven)

Session Classification: Recent Experimental Results III