Optical properties of MgO implanted with Ce and Li with different annealing conditions

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Defect centers in diamond [1] and in SiC [2] are the most established spin centers as optically accessible solid-state qubits. To develop other widegap host materials with new qubit functionalities [3], based on theoretical predictions of qubit host materials with long coherence times [3,4], here we investigate the optical properties of isolated color centers with Ce- and Li-implanted MgO.

We prepare several series of MgO substrates with different implantation conditions: Series A with Ce implantation and Series B with subsequent Li and Ce implantations. The implantation power and dose of Ce (Li) are 100 keV (13 keV) and 1.0×10^{14} atoms/cm^2 (3.0×10^{14} atoms/cm^2), respectively. Species are implanted at room temperature in air, and then, the substrates are annealed at T_a = 600-1000°C in Ar atmosphere for 2 hours. In oxides, possible states of the Ce atom are Ce^{3+}, Ce^{2+}, and Ce-Ce clusters, in which only Ce^{3+} center shows bright fluorescence [5]. Figure 1 shows the typical photoluminescence (PL) spectroscopy signal of the samples with T_a = 800°C measured by a spectrometer with excitation wavelength at 450 nm and power with 1 mW. In Series A (B), the samples with $T_a \leq$ 800°C ($\leq$ 900°C) show clear peaks at around 480 nm and 520 nm corresponding to the optical transitions of Ce^{3+} [5]. At $T_a \geq$ 600°C, the signal of Series B is larger than that of Series A, which is due to the increase of Ce^{3+}/Ce^{2+} ratio in Series B with the charge state compensation by Li^+ ion. Further increase of the T_a annihilates the peaks, which is most probably due to the formation of the Ce-Ce clusters [6].

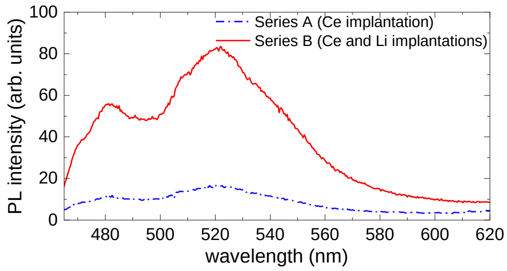

Figure 1　Photoluminescence spectrum of Ce implanted MgO annealed at 800°C with different implantation conditions.

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