

Spectral and luminescence properties of Mn^{2+} ions in green luminescence crystal phosphors

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Optical properties of Mn^{2+} ions in green luminescence crystal phosphors based on CaF_2 , CdF_2 , $CaAlF_5$, Zn_2SiO_4 , and Zn_2GeO_4 base have been studied. The calculated crystal field parameters and level energies agree well with experimental data. The decreased B parameter values in silicate and germanate crystal phosphors are associated with increased bond covalence. The data presented are in agreement with the ligand positions in the nepheloauxetic sequence.

Исследованы оптические свойства ионов Mn^{2+} в кристаллофосфорах с зеленой люминесценцией на основе CaF_2 , CdF_2 , $CaAlF_5$, Zn_2SiO_4 , Zn_2GeO_4 . Рассчитанные значения параметров кристаллического поля и энергий уровней находятся в хорошем согласии с экспериментом. Уменьшение параметра B для силикатных и германатных кристаллофосфоров связывается с возрастанием ковалентности связи. Представленные данные согласуются с положением лигандов в нефелоауксетическом ряду.

Manganese is a typical transition metal and can present in crystals at different oxidation degrees. The absorption spectra of Mn^{2+} ion ($3d^5$ electron configuration) in single crystals (MnF_2 , $MnCO_3$) and in coordination compounds have been interpreted within the frame of the crystal field theory (CFT) [1, 2]. Of a particular interest are efficient crystal phosphors of various emission colors containing Mn^{2+} ion additives [3]. The ion ground state is ${}^6A_1({}^6S)$ while the excited levels are ${}^4T_1({}^4G)$, ${}^4T_2({}^4G)$, $E({}^4G)$, ${}^4T_2({}^4D)$, $E({}^4D)$, ${}^4T_1({}^4P)$ ones. The transitions within these states define the main spectral and luminescence properties (the emission color, absorption and excitation spectra) of Mn^{2+} ions in various compounds. The spin-orbital interaction influences the free ion terms as a rule to a lesser extent than the field of nearest ligands. The energy diagrams for tetrahedral, octahedral, and cubic crystal fields are similar to each other but the level split values are different. The luminescence occurs at the ${}^4T_1({}^4G) \rightarrow {}^6A_1({}^6S)$ transition. As the crystal

field strength (D_q parameter) increases, the excited level energy of Mn^{2+} ion drops sharply and depends on the field local symmetry. Therefore, the bivalent manganese emits in orange or red spectral region in most crystals where it has the coordination number (CNo) equal to 6. At CNo 4 or 8, the luminescence is green in most cases.

Many of commercial crystal phosphors require a further modification. In first time, those are cathodoluminophors in both long and moderate afterglow screens (K-35, K-62, KLZD-10, P1G1, P1, P7, P39) [1–3]. The interest in Mn^{2+} containing structures remains stable as their application fields are broadened and new requirements are demanded on the luminophor properties. Such a field is, for example, the investigations in plasma display panels being under an intensive development [4]. In this case, a crystal phosphor is required emitting efficiently in the 500–530 nm range under excitation from the vacuum UV region and having a moderate afterglow (less than 10 ms to the e-fold decrease of the initial brightness). The search for stable electroluminophors