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ELECTRON-HOLE TRAPPING CENTERS IN UV-IRRADIATED $Na_2SO_4 - Mn$ AND $K_2SO_4 - Mn$

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Alkali metal sulfates activated by transition metals, which have an unfilled d-shell, are used in laser technology and as detectors for various radiations. In an irradiated $K_2SO_4 - Mn$ crystal at temperature of 80 K, a broad peak of thermally stimulated luminescence (TSL) at 120–190 K was found. The light sum under the low-temperature TSL peak at 120–190 K in irradiated $K_2SO_4 - Mn$ is several times greater than the light sum under the TSL peak at 190–200 K in pure K_2SO_4under the same conditions.

It is assumed that the increase in the light sum under the TSL peak of 120-190 K in $K_2SO_4 - Mn$ is associated with an increase in the concentration of self-trapped holes SO_4^-. Self-localized holes are formed in this crystal in addition to the electronic Mn^+– trapping centers.

Thus, in $Na_2SO_4 - Mn$ and $K_2SO_4 - Mn$ crystals, impurity electron-hole trapping centers are effectively created as a result of the localization of electrons with Mn^{2+}impurities.

We have investigated the nature of emission center and recombination emission at trapping centers in $K_2SO_4 - Mn^{2+}$and $Na_2SO_4 - Mn^{2+}$ crystals. When irradiated with ultraviolet photons with an energy of 5.9-6.2 eV, recombination emission was detected in these crystals at 1.82-1.84 eV for the $Na_2SO_4 - Mn$ crystal and 1.95-1.97 eV for the $K_2SO_4 - Mn$.

The detected emissions at 1.82-1.84 eV for the $Na_2SO_4 - Mn$ crystal are excited in the spectral range 3.34 eV and 3.56 eV, 3.08 eV and 2.79 eV and 2.41 eV at 80 K and 300 K. Similar emissions of 1.95-1.97 eV for the $K_2SO_4 - Mn$ crystal are excited in the spectral range 3.33 eV, 3.52 eV, 2.79 eV and 3.08 eV and 2.39 eV at 80 K and 300 K.

The emission of the Mn^{2+} ion in the Na_2SO_4 and K_2SO_4 matrices is assumed to be excited in three spectral groups slightly different for the two crystals. Similar results were obtained by the authors of [1] for a $ZnS - Mn$ piezoelectric crystal. According to the authors' [1] assumption, the first high-energy excitation band is associated with emission center transitions in the Mn^{2+}ion located in the main interstitial positions. The remaining two groups of excitation bands are connected by the formation of electron-hole trapping centers near the vacancy of the Zn ion or its location in the interstitial.

Our experimental results are interpreted as follows: During irradiation with UV photons, electron-hole pairs are created. The electron-hole pair transfers energy to impurities, and excitations of Mn^{2+}impurities are observed at 3.34 eV and 3.56 eV, followed by Mn^{2+}emissions in both crystals.

It is well known that electrons are well trapped by Mn^{2+}impurities according to the reaction $Mn^{2+} + e^- \rightarrow Mn^+$ and impurity electron-hole trapping centers of two types Mn^+– SO_4^-depending on the positions of the impurity in the lattice Na_2SO_4 and K_2SO_4. The observed phosphorescence for two crystals at 2.79 eV and 2.39-2.41 eV confirms our assumptions about the formation of impurity trapping centers. The correlation between impurity trapping centers and intrinsic SO_4^{3-}–SO_4^-- trapping centers for pure K_2SO_4 and Na_2SO_4 crystals is discussed.

REFERENCES

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