

## LUMINESCENCE OF $\alpha$ -QUARTZ

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The luminescence of pure crystalline  $\alpha$ -quartz mainly is related to the self-trapped excitons, which appear under irradiation. The energetic yield for the case of ionising radiation is high and achieves 30 %. Nevertheless, less pure crystalline quartz contains “technological” impurities in different concentration and different structural positions. The “technological” nature of impurities is connected with condition of material production (including natural quartz crystal growth) and their presence could be undesirable in most cases, however, unavoidable.

For the present time some success is achieved in interpretation of “technological” impurities in silicon dioxide. The luminescence properties of germanium, copper, silver are understood sufficiently well, however that for aluminium, alkali ion only partial understanding is achieved for  $\alpha$ -quartz crystal and silica glass. Many others impurities such as Cl, F, Ca, Mg do not open their luminescence properties yet.

The Ge-doped  $\alpha$ -quartz exhibits very strong luminescence situated at 2.3 eV under ionising irradiation at temperatures below 200 K and is very similar to STE luminescence of pure quartz, therefore is attributed to STE near Ge. Significant is strong difference of this luminescence from that of silica glass doped with Ge. The energetic yield (emitted energy per absorbed) is about 30% under x-ray irradiation. The quantum yield of the photoluminescence is also high with value about 0.4.

Alkali and noble metals ions in  $\alpha$ -quartz and their association with aluminium provide specific luminescence centers with different properties in each case. Luminescence center of noble ions,  $\text{Cu}^+$  and  $\text{Ag}^+$  we got by exchange of alkali ions in part natural and synthetic  $\alpha$ -quartz crystal samples possessing high amount of aluminum and alkali impurities. However, the  $[\text{AlO}_4/\text{Me}^+]$  is not responsible for the obtained luminescence centers. It corresponds to complexes of two or more aluminium related defects with not yet known structure. Before exchange with noble ions this complexes provide luminescence at 3 eV with time constant about 2 ms. This luminescence is quenched above 200 K. After exchange of alkali ions to noble ions this luminescence disappears and specific luminescence of noble ions appears. The  $\text{Cu}^+$  related luminescence band is situated at 3.4 eV and decay time constant about 50  $\mu\text{s}$ , whereas for  $\text{Ag}^+$  the band is at 4.75 eV with time constant about 30  $\mu\text{s}$ . In both cases decay time constant increases to 4 K. This effect together dependence of decay time on atomic number shows on triplet nature of the luminescence.

The complexes  $[\text{AlO}_4/\text{Me}^+]$  provide UV luminescence at 6 eV excitable only in recombination process and correspond to tunnelling transitions between  $\text{AlO}_4$  captured a hole and alkali atom. This luminescence is strong at low temperature under electron beam excitation.

An UV luminescence at 5 eV could be induced by neutron irradiation of pure crystalline quartz. This luminescence also was observed under destructive electron beam excitation [1].

[1] A. Trukhin, P. Liblik, Ch. Lushchik, J. Phys. B (in press).