Luminescent and optical spectroscopy of ZnO crystals obtained by new method based on the halide vapor transport

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Zinc oxide (ZnO) crystals have recently drawn attention due to a relatively low price and to their application perspectives in various fields. The recent viable direction of their application is the fabrication of nanotemplates, which give the possibility of obtaining various nanomaterials as promising structures for optoelectronics and photonics. The easiest and most cost-effective method to obtain nanotemplates is electro-chemical etching, which, however, can be efficiently used only on the homogeneously doped substrates with controlled high conductive properties. Commercially available crystals and substrates are usually obtained by hydrothermal methods. However, the corresponding equipment is very expensive, and the presence of mobile Li or K ions in these materials usually limits their utilization in electronics. In this regard, great interest is the elaboration of cost-effective and simpler growth methods of ZnO single crystals with controlled electrical parameters and impurity composition varied in a wide range. One of the most suitable methods for obtaining such crystals is the chemical vapor transport.

The photoluminescence (PL), transmittance and IR reflectance spectra were investigated for ZnO single crystals grown by the HCl chemical vapor transport technique. Electrical parameters were also calculated from the Hall effect measurements. The characteristics of ZnO:HCl crystals basically depend on the centers caused by the chlorine impurity. The deep acceptors attributed to Cl-V_{Zn} centers with activation energy of 640±60 meV influence on the PL and optical properties. Cl donors cause luminescent and electric properties of high conductive crystals; they have activation energy of 115±15 meV according to PL spectra and 67±18 meV according to the electrical properties. Obtained crystals are characterized also by a strong optical absorption in the near-IR spectral range.

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