

Crystalization of Alkali Halides Doped with Several Kinds of Foreign Ions and Their  
Application to Optically-Active Media

Mamoru Baba, Rongbin Ye, Koji Ohta and Kazume Nishidate

Department of Electrical and Electronic Engineering

Faculty of Engineering, Iwate University

A color-center laser using alkali halide crystals has been developed as a tunable solid laser in the near-infrared region. On the other hand, dielectric crystals containing transition metal ions especially rare-earth elements have been practically used as a solid laser medium, since rare-earth ions show an effective luminescence in these oxide crystals having a low symmetry lattice structure. From this point of view, we tried to search new light-emitting species and a new nonlinear optics in alkali halide crystals which work as a solid laser medium. For this purpose, we prepared the NaCl and KCl crystals doubly-doped with manganese (Mn) and chalcogen ions such as S and Se and systematically investigated optical absorption and photoluminescence characteristics of them. For comparison, NaCl crystals doubly-doped with Cd and S ions were also studied.

Generally speaking, the alkali halide crystals doped with Mn and S (Se) ions had a strong tendency for these Mn and S (Se) ions to solve dispersedly into the lattice, while the alkali halide crystals doped with Cd and S ions had a tendency for such Cd and S ions to coagulate each other and to form a new crystalline phase of CdS. There is a striking difference between two cases.

Especially, it was found at the first time that when the KCl crystals doped with Mn and S (Se) ions are irradiated with uv light through an Hg lamp,  $S_2^-$  ( $Se_2^-$ ) molecular ions are formed. These chalcogen molecular ions are known to show a peculiar vibronic luminescence related to both a molecular vibration and an electronic transition. It should be noted that formation of such  $S_2^-$  ( $Se_2^-$ ) molecular ions is possible only under coexisting of Mn ions and did not occur in the case of alkali halide crystals singly-doped with Mn ions. In addition, these molecular ions were more effectively created by the doubly-doping method using together a diffusion technique, which is useful from the point of engineering. As an idea of a laser oscillation by a superluminescence making use of such a vibronic emission is reported, it will be necessary for a further investigation to be performed systematically.

On the other hand, the alkali halide crystals containing semiconducting CdS fine particles are expected to be used as a new system where nonlinear optics will occur due to a quantum-mechanic confinement of carriers. We would like to investigate these materials further as optically-active media by controlling a size of CdS micro-crystalline particles.