

Growth of Functional Oxide Single Crystals from a Sodium Chloride Flux

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Summary

Sodium chloride was successfully used as a new flux to grow the layered perovskite-type $\text{Na}_2\text{Ca}_2\text{Nb}_4\text{O}_{13}$ single crystals by a slow cooling method. Layered perovskite-type compounds are attractive because of their properties such as luminescence and ionic conduction through the interlayer. Sodium chloride has a low melting point with sufficient solubility in water. In addition, NaCl is nontoxic to humans.

The crystal growth of $\text{Na}_2\text{Ca}_2\text{Nb}_4\text{O}_{13}$ was conducted by heating a mixture of solute and flux at $1100\text{ }^\circ\text{C}$ for 10 h, and then cooling to $450\text{ }^\circ\text{C}$ at a rate of $5\text{ }^\circ\text{C}/\text{h}$. The rectangular thin plate-shaped crystals with widths of up to 1.2 mm and thicknesses of 0.03 mm were grown. The obtained crystals were colorless and transparent. Typical $\text{Na}_2\text{Ca}_2\text{Nb}_4\text{O}_{13}$ crystals are shown in Fig.1. Taking the sizes and forms of grown crystals into account, the most suitable solute content for the growth of $\text{Na}_2\text{Ca}_2\text{Nb}_4\text{O}_{13}$ crystals was 0.4 mol%. The resulting crystals could be readily separated from the NaCl flux in warm water. Sodium chloride was found to be a suitable flux to grow $\text{Na}_2\text{Ca}_2\text{Nb}_4\text{O}_{13}$ crystals.

The indices of well-developed basal faces of $\text{Na}_2\text{Ca}_2\text{Nb}_4\text{O}_{13}$ crystals were $\{001\}$. The two-dimensional growth is consistent with the layered structure. No water was detected in the crystals obtained. The crystal structure was essentially of the layered perovskite type with the layer thickness corresponding to the four corner-shared octahedra. The lattice parameters were determined as $a=5.489(1)\text{ \AA}$, $b=5.519(1)\text{ \AA}$, and $c=36.360(7)\text{ \AA}$, suggesting an orthorhombic symmetry.

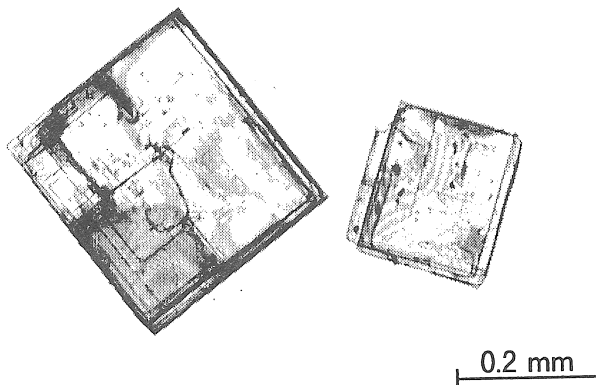


Fig.1 $\text{Na}_2\text{Ca}_2\text{Nb}_4\text{O}_{13}$ crystals grown from NaCl flux.