Growth of KDP single crystals from solutions with KMnO4 additives.

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Crystals of potassium dihydrogen phosphate are widely applied in science and techniques, medicine and industry. KDP single crystals were grown using a temperature gradient technique with feeding in a concentration convection regime [1] at a constant solution supercooling of 3.5-4 °C. We used z-cuts of a large crystal as seeds, and solutions of two compounds: 1) analytical grade potassium dihydrogen phosphate KH2PO4 (KDP) with a concentration of 270 g/L, analytical grade KOH 10 g/L, distilled water and the addition of 20 - 400 mg/L of analytical grade potassium permanganate KMnO4, pH of the solution was 4.7; and 2) KDP 310 g/L, KOH 12 g/L, distilled water and 0-200 mg/L of KMnO4, pH=5. We added alkali to prevent crystal thinning.

We have found that growth of the (101) faces of a KDP (KH2PO4) crystal is suppressed, and the growth rate of the (100) faces passes through the maximum with increasing addition of KMnO4 to a solution with pH=4.7. MnO2 particles deposit on the (100) faces promoting their growth. The [MnH2PO4]2+ complexes are adsorbed on the (100) and (101) faces inhibiting the growth up to complete stoppage. The Mn3+ ion substitutes the K+ ion in the crystal structure.

The KDP crystals with the growth sectors uniformly doped with manganese were grown in solutions with pH=4.7 and addition of KMnO4. At higher pH, potassium permanganate undergoes chemical transformations in a KDP solution. As a result, the concentration of manganese compounds decreases with time in the bulk solution and, consequently, in the growing crystals. The concentration of manganese in these crystals decreases along the growth directions.

The X-ray and electronic paramagnetic resonance data show that manganese is incorporated into the crystal structure in the form of Mn3+ substituting a K+ ion. The optical absorption spectra of KDP solutions with KMnO4 additives and grown crystals have been studied. The effective coefficients of the quadratic non-linear susceptibility of crystal samples with different concentrations of manganese have been measured. The increase of manganese concentration in the growth sectors up to 2.3•10^-5 of the total mass fraction diminishes the effective coefficients of the quadratic non-linear susceptibility.


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