

Formation and diffusion of anionic vacancies in leucosapphire

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The interaction of Schottky defects in leucosapphire at the anionic non-stoichiometry formation in the crystal resulting from high-temperature annealing has been studied. The crystals were annealed in a medium having a reducing chemical potential ϵ of -230 to -265 kJ/mol. The non-stoichiometry intensity and type was controlled by optical absorption in UV region. A procedure has been proposed to estimate the reducing chemical potential of the annealing medium in an open system. Diffusion dynamics of anionic vacancies in the crystal at 1900°C has been studied. The interaction between anionic and cationic vacancies in leucosapphire at the reducing annealing has been shown to result in formation of stoichiometric crystal matrix having a lowered optical absorption in UV region. Constants D_0 and E for estimation of the effective diffusion coefficient of anionic vacancies in leucosapphire at the crystal annealing within 1700 to 2000°C temperature range have been determined empirically. A possibility to reduce the UV absorption of finished articles has been demonstrated.

Исследован процесс взаимодействия дефектов по Шоттки в лейкосапфире при формировании в кристалле анионной расстехиометрии в результате высокотемпературного отжига. Кристаллы отжигали в среде с восстановительным химическим потенциалом ϵ от -230 до -265 кДж/моль. Интенсивность и вид расстехиометрии контролировали по оптическому поглощению лейкосапфира в УФ области спектра. Предложена методика оценки восстановительного химического потенциала среды отжига для открытой системы. Исследована динамика диффузии анионных вакансий в кристалле при 1900°C . Показано, что в результате взаимодействия анионных и катионных вакансий в лейкосапфире при восстановительном отжиге образуется кристаллическая матрица стехиометричного состава, имеющая пониженное оптическое поглощение в УФ-области. Эмпирически определены константы D_0 и E для оценки эффективного коэффициента диффузии анионных вакансий в лейкосапфире при отжиге кристалла в интервале температур 1700 – 2000°C . Показана возможность снижения УФ-поглощения в готовых изделиях.

The important performance properties of leucosapphire articles, such as mechanical strength and radiation resistance, optical absorption, etc., are defined by the point defects of the crystal matrix [1–5]. There are numerous works aimed at the problems of formation and diffusion of point defects in crystals due to various factors, e.g., mechanical stresses, electric fields, concentration gradient of the diffusing particles distribution, etc.[6–9]. When corundum crys-

tals are grown, vacancy type distortions, i.e., the Schottky defects, arise in the crystal structure periodicity that form characteristic optical absorption centers in the UV spectral region. The high-temperature annealing in controlled gas media is an effective way to influence those defects [10, 11].

In this work, studied are the formation kinetics of anionic non-stoichiometry in leucosapphire due to high-temperature carbon-containing annealing medium as well as the