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Chukochenite, $(Li_{0.5}Al_{0.5})Al_2O_4$, a new lithium oxyspinel mineral from the Xianghualing skarn, Hunan Province, China

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Abstract

Chukochenite, $(Li_{0.5}Al_{0.5})Al_2O_4$, is a new mineral species from the Xianghualing skarn, Hunan Province, southern China. It occurs as subhedral to euhedral crystals up to 200 μm across in the green rock of Xianghualing skarn, closely associated with fluorite, phlogopite, chrysoberyl, margarite, chlorite, ferronigerite-2*N*1*S*, and zinconigerite-2*N*1*S*. The crystals are colorless and transparent with a vitreous luster. Chukochenite is brittle with irregular fracture, has a Mohs hardness of 8, and shows light red fluorescence under 253.7 nm UV radiation and light green fluorescence under 365 nm UV radiation. The calculated density is 3.771 g/cm^3. Chukochenite is optically biaxial (–) with $\alpha = 1.79(2)$, $\beta = 1.82(2)$, and $\gamma = 1.83(2)$ (589 nm). The calculated $2V$ is 60°, with the optical orientations *X*, *Y*, and *Z* parallel to the crystallographic *a*, *b*, and *c*, respectively. Electron microprobe analysis (Li by LA-ICP-MS) yielded in wt% Al_2O_3 80.70, Fe_2O_3 8.16, Li_2O 3.68, ZnO 3.25, MnO 2.49, MgO 1.70, Na_2O 0.11, CaO 0.08, TiO_2 0.02, K_2O 0.01, and Cr_2O_3 0.01 (total 100.24 wt%), giving an empirical formula $[(Li_{0.355}Al_{0.138}Na_{0.005}Ca_{0.002})_{\Sigma 0.5}(Al_{0.145}Fe^{+3}_{0.147}Mg_{0.061}Zn_{0.058}Mn_{0.051}Si_{0.001})_{\Sigma 0.463}]Al_2O_4$ on a basis of 4 O atoms per formula unit. Chukochenite is orthorhombic, *Imma*, $a = 5.659$ (1), $b = 16.898$ (1), $c = 7.994$ (1) Å, $V = 764.46$ (8) Å^3, and $Z = 12$. The nine strongest lines of powder XRD [*d* in Å (*I*) (*hkl*)] are: 2.405 (53) (231); 1.996 (29) (260); 1.535 (77) (303); 1.413 (100) (264); 1.260 (52) (2 12 0); 1.068 (36) (1 13 4); 1.039 (61) (503); 0.999 (59) (008); and 0.942 (35) (3 13 4). Chukochenite has a framework structure of spinel with low symmetry (orthorhombic *Imma*) due to the ordering of Li cations over octahedrally coordinated sites, which has not been previously reported for synthetic $(Li_{0.5}Al_{0.5})Al_2O_4$. This structure type is based on a framework of AlO_4 tetrahedra, AlO_6, and LiO_6 octahedra. AlO_6 edge-sharing octahedra form chains along the *a* axis. AlO_6 octahedra and LiO_6 octahedra in a 2:1 ratio share edges, forming octahedral chains along *b*. These octahedral chains are connected by AlO_4 tetrahedra and each corner of an AlO_4 tetrahedron shares with three AlO_6 octahedra or two AlO_6 + one LiO_6 octahedra. The discovery of chukochenite adds a new perspective on the cation ordering and the mechanism of luminescence and magnetism in $(Li_{0.5}Al_{0.5})Al_2O_4$.

Keywords: Chukochenite, new mineral, $(Li_{0.5}Al_{0.5})Al_2O_4$, crystal structure, optical property, XRD, EPMA, Raman spectroscopy; Lithium, beryllium, and boron: Quintessentially crustal