

Krotite, CaAl_2O_4 , a new refractory mineral from the NWA 1934 meteorite

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ABSTRACT

Krotite, CaAl_2O_4 , occurs as the dominant phase in an unusual Ca-,Al-rich refractory inclusion from the NWA 1934 CV3 carbonaceous chondrite. Krotite occupies the central and mantle portions of the inclusion along with minor perovskite, gehlenite, hercynite, and Cl-bearing mayenite, and trace hexamolybdenum. A layered rim surrounds the krotite-bearing regions, consisting from inside to outside of grossite, mixed hibonite, and spinel, then gehlenite with an outermost layer composed of Al-rich diopside. Krotite was identified by XRD, SEM-EBSD, micro-Raman, and electron microprobe. The mean chemical composition determined by electron microprobe analysis of krotite is (wt%) Al_2O_3 63.50, CaO 35.73, sum 99.23, with an empirical formula calculated on the basis of 4 O atoms of $\text{Ca}_{1.02}\text{Al}_{1.99}\text{O}_4$. Single-crystal XRD reveals that krotite is monoclinic, $P2_1/n$; $a = 8.6996(3)$, $b = 8.0994(3)$, $c = 15.217(1)$ Å, $\beta = 90.188(6)$, and $Z = 12$. It has a stuffed tridymite structure, which was refined from single-crystal data to $R_1 = 0.0161$ for $1014 F_o > 4\sigma F$ reflections. Krotite is colorless and transparent with a vitreous luster and white streak. Mohs hardness is $\sim 6\frac{1}{2}$. The mineral is brittle, with a conchoidal fracture. The calculated density is 2.94 g/cm^3 . Krotite is biaxial (–), $\alpha = 1.608(2)$, $\beta = 1.629(2)$, $\gamma = 1.635(2)$ (white light), $2V_{\text{meas}} = 54.4(5)^\circ$, and $2V_{\text{calc}} = 55.6^\circ$. No dispersion was observed. The optical orientation is $X = \mathbf{b}$; $Y \approx \mathbf{a}$; $Z \approx \mathbf{c}$. Pleochroism is colorless to very pale gray, $X > Y = Z$. Krotite is a low-pressure CaAl_2O_4 mineral, likely formed by condensation or crystallization from a melt in the solar nebula. This is the first reported occurrence of krotite in nature and it is one of the earliest minerals formed in the solar system.

Keywords: Krotite, CaAl_2O_4 , new mineral, refractory inclusion, NWA 1934 meteorite, CV3 carbonaceous chondrite, XRD, EBSD