

Crystal Data: Monoclinic. *Point Group:* 2/m. As a single euhedral crystal, 4.4 μm across.

Physical Properties: *Cleavage:* n.d. *Fracture:* n.d. *Tenacity:* n.d. *Hardness:* = n.d.
D(meas.) = n.d. D(calc.) = 4.27

Optical Properties: n.d. *Color:* n.d. *Streak:* n.d. *Luster:* n.d.
Optical Class: n.d.

Cell Data: Space Group: C2/c. *a* = 17.10 *b* = 5.03 *c* = 7.06 *β* = 107° *Z* = 4

X-ray Powder Pattern: Calculated pattern.

8.176 (100), 2.882 (79), 2.742 (79), 4.088 (51), 2.441 (45), 3.376 (41), 1.695 (35)

Chemistry:	(1)	(2)
TiO ₂	59.75	70.16
Al ₂ O ₃	15.97	29.84
Sc ₂ O ₃	10.29	
ZrO ₂	9.18	
Y ₂ O ₃	2.86	
FeO	1.09	
CaO	0.44	
SiO ₂	0.20	
MgO	0.10	
Total	99.87	100.00

(1) Murchison CM2 carbonaceous chondrite meteorite; average of 6 electron microprobe analyses; corresponds to (Al_{1.17}Sc_{0.56}Y_{0.10}Ti⁴⁺_{0.08}Fe_{0.06}Ca_{0.03}Mg_{0.01})_{Σ=2.01}(Ti⁴⁺_{2.71}Zr_{0.28}Si_{0.01})_{Σ=3.00}O₉.

(2) Al₂Ti₃O₉.

Mineral Group: Schreyerite group.

Occurrence: An ultra-refractory phase in matrix of a carbonaceous chondrite meteorite, likely formed in the solar nebula, either by gas-solid condensation or by crystallization from a Ca-Al-rich melt with solar-like oxygen isotopic composition, under high-temperature (~1400-1500 °C) and low-pressure (~10⁻⁴-10⁻⁵ bar) conditions in the CAI-forming region near the protosun.

Association: Corundum, serpentine, tochilinite, olivine.

Distribution: Murchison CM2 carbonaceous chondrite meteorite.

Name: Honors Chi Ma (b. 1968), mineralogist at California Institute of Technology, USA, for his contributions to meteorite mineralogy and discovery of 45 new minerals, including 14 refractory phases formed in the solar nebula and 11 high-pressure minerals from shock metamorphism of meteorite parent bodies.

Type Material: Meteorite Collection, Hawai'i Institute of Geophysics and Planetology, University of Hawai'i, Mānoa, Honolulu, USA (Murchison section UH80).

References: (1) Krot, A.N., K. Nagashima, and G.R. Rossman (2020) Machiite, Al₂Ti₃O₉, a new oxide mineral from the Murchison carbonaceous chondrite: A new ultra-refractory phase from the solar nebula. *Amer. Mineral.*, 105(2), 239-243.