## Kamiokite $Fe_2^{2+}Mo_3^{4+}O_8$



**Crystal Data:** Hexagonal. *Point Group:* 6*mm*. As thick tabular hexagonal crystals, to 3 mm, hemimorphic pyramidal with {0001}, {10$\overline{1}$0}, {10$\overline{1}$1}, and smaller {10$\overline{1}\overline{1}$}; also granular.

**Physical Properties:** *Cleavage:* {0001}, perfect. *Fracture:* Even. Hardness = 3–4.5 VHN = 545–678, 600 average (50 g load); 380–410, 385 average (25 g load). D(meas.) = 5.96 D(calc.) = 6.02

**Optical Properties:** Opaque. *Color:* Iron-black; gray with an olive tint in reflected light. *Streak:* Black. *Luster:* Metallic to submetallic.
*Optical Class:* Uniaxial (–). *Anisotropism:* Strong; light brownish gray to dark greenish gray. *Bireflectance:* Strong; gray to olive-gray.
$R_1$–$R_2$: (400) 19.0–25.4, (420) 18.6–25.0, (440) 18.2–24.6, (460) 17.8–24.2, (480) 17.4–23.8, (500) 17.1–23.5, (520) 16.8–23.2, (540) 16.6–23.0, (560) 16.4–22.7, (580) 16.1–22.5, (600) 15.9–22.3, (620) 15.8–22.2, (640) 15.8–22.3, (660) 15.9–22.4, (680) 16.0–22.6, (700) 16.3–22.7

**Cell Data:** *Space Group:* $P6_3mc$. $a = 5.781(1)$ $c = 10.060(1)$ Z = 2

**X-ray Powder Pattern:** Kamioka mine, Japan.
5.03 (100), 3.55 (90), 2.509 (75b), 2.430 (55), 2.006 (40), 2.785 (35), 1.5678 (35)

**Chemistry:**

| | (1) | (2) | (3) |
|---|---|---|---|
| $SiO_2$ | | 0.95 | |
| $TiO_2$ | | 1.06 | |
| $MoO_2$ | 71.25 | 64.08 | 72.76 |
| $VO_2$ | | 2.31 | |
| $Al_2O_3$ | | 0.86 | |
| $Fe_2O_3$ | | 4.81 | |
| FeO | 27.04 | 23.11 | 27.24 |
| MnO | 0.41 | | |
| ZnO | | 0.45 | |
| CuO | | 2.48 | |
| Total | 98.70 | 100.11 | 100.00 |

(1) Kamioka mine, Japan; by electron microprobe, average of three analyses; original analysis Fe 21.02%, Mn 0.32%, Mo 53.43%, here calculated to oxides; corresponding to $(Fe_{2.01}Mn_{0.03})_{\Sigma=2.04}Mo_{2.98}O_8$. (2) Mohawk mine, Michigan, USA; by electron microprobe, average of seven analyses, $Fe^{2+}$:$Fe^{3+}$ from structural considerations; corresponds to $(Fe^{2+}_{1.54}Cu_{0.16}Fe^{3+}_{0.15}Si_{0.08}Al_{0.04}Zn_{0.03})_{\Sigma=2.00}(Mo_{2.52}Fe^{3+}_{0.15}V_{0.14}Fe^{2+}_{0.08}Ti_{0.07}Al_{0.04})_{\Sigma=3.00}O_8$. (3) $Fe_2Mo_3O_8$.

**Occurrence:** In quartz-molybdenite stockwork veins associated with granite porphyry dikes (Japan); in fissure veins filled during low-grade regional metamorphism of basalt (Michigan, USA).

**Association:** Molybdenite, potassic feldspar, fluorite, ilmenite, scheelite, quartz (Kamioka mine, Japan); domeykite, algodonite, nickeline, maucherite, koutekite, safflorite, silver, molybdenite, calcite (Michigan, USA); magnetite, ilmenite, molybdenite, graphite (Carajas deposit, Brazil).

**Distribution:** From the Kamioka Ag–Pb–Zn mine, Gifu Prefecture, Japan. In the USA, in the Mohawk and Ahmeek mines, Keweenaw Co., Michigan. From the Carajas deposit, locality not otherwise specified, Brazil.

**Name:** For the occurrence at the Kamioka mine, Japan.

**Type Material:** Geological Survey of Japan, Tsukuba, M17968; National Science Museum, Tokyo, Japan.

**References:** (1) Sasaki, A., S. Yui, and M. Yamaguchi (1985) Kamiokite, $Fe_2Mo_3O_8$, a new mineral. Mineral. J. (Japan), 12, 393–399. (2) (1988) Amer. Mineral., 73, 191 (abs. ref. 1). (3) Johan, Z. and P. Picot (1986) Kamiokite, $Fe_2Mo_3O_8$, a tetravalent molybdenum oxide: new data and occurrences. Tschermaks Mineral. Petrog. Mitt., 35, 67–75. (4) Endo, Y., Y. Kanazawa, and A. Sasaki (1986) External form of kamiokite crystals. Bull. Geol. Survey of Japan, 37, 367–371. (5) Kanazawa, Y. and A. Sasaki (1986) Structure of kamiokite. Acta Cryst., C42, 9–11.