Ilmenite $Fe^{2+}TiO_3$

Crystal Data: Hexagonal. *Point Group:* $\overline{3}$. As thick tabular crystals, with dominant base, to rhombohedral, to 25 cm. Skeletal, granular, massive; as lamellar exsolutions in hematite or magnetite. *Twinning:* Simple on {0001}; lamellar on $\{10\overline{1}1\}$.

Physical Properties: *Cleavage:* {0001} and $\{10\overline{1}1\}$, partings. *Fracture:* Conchoidal to subconchoidal. *Tenacity:* Brittle. Hardness = 5–6 VHN = 566–698 (100 g load). D(meas.) = 4.72 D(calc.) = 4.789 Weakly magnetic.

Optical Properties: Opaque. *Color:* Iron-black; gray with a brownish tint in reflected light. *Streak:* Black to reddish brown. *Luster:* Metallic to submetallic.
Optical Class: Uniaxial (–). *Anisotropism:* Strong; in shades of gray. *Bireflectance:* Strong; *O* = pinkish brown, *E* = dark brown.
R_1–R_2: (400) 20.0–21.2, (420) 19.5–20.8, (440) 19.0–20.4, (460) 18.5–20.1, (480) 18.1–20.0, (500) 18.0–19.8, (520) 18.0–19.8, (540) 18.0–19.7, (560) 18.0–19.6, (580) 18.0–19.8, (600) 18.1–19.9, (620) 18.2–19.9, (640) 18.3–19.9, (660) 18.4–20.0, (680) 18.5–20.1, (700) 18.6–20.4

Cell Data: *Space Group:* $R\overline{3}$ (synthetic). $a = 5.08854(7)$ $c = 14.0924(3)$ Z = 6

X-ray Powder Pattern: Synthetic.
2.754 (100), 2.544 (70), 1.7261 (55), 1.8683 (40), 1.4686 (35), 3.737 (30), 2.237 (30)

Chemistry:

	(1)	(2)		(1)	(2)
SiO_2	0.02		Cr_2O_3	0.01	
TiO_2	52.61	52.65	FeO	42.77	47.35
Al_2O_3	0.06		MnO	0.46	
Fe_2O_3	2.22		MgO	2.30	
V_2O_3	0.13		Total	100.58	100.00

(1) Marcy massif, Adirondacks, New York, USA; by electron microprobe, Fe^{2+}:Fe^{3+} from charge balance; corresponds to $(Fe^{2+}_{0.88}Mg_{0.08}Fe^{3+}_{0.04}Mn_{0.01})_{\Sigma=1.01}Ti_{0.98}O_3$. (2) $FeTiO_3$.

Polymorphism & Series: Forms three series, with ecandrewsite, with geikielite, and with pyrophanite.

Mineral Group: Ilmenite group.

Occurrence: A common accessory mineral disseminated in igneous rocks, as granites, gabbros, and kimberlites; in granite pegmatites, carbonatites, and high-grade metamorphic rocks; may attain economic concentration in layered mafic intrusions and in "black sand" placer deposits.

Association: Magnetite, hematite, rutile, ulvöspinel, pyrrhotite, apatite.

Distribution: Widespread; well-crystallized from numerous localities. In the Vishnevy-Il'men Mountains, Southern Ural Mountains, Russia, large crystals; from the Lovozero massif, Kola Peninsula. In Norway, at Tellnes and Snarum; large crystals from Kragerøand Arendal. From Binntal, Valais, Switzerland. At St. Cristophe, Bourg d'Oisans, Isère, France. In the USA, at Quincy, Norfolk Co., Massachusetts; from Litchfield, Litchfield Co., Connecticut; large crystals from the Lake Sanford area, Essex Co., New York. At Allard Lake, Quebec; Bancroft, Ontario; and elsewhere in Canada. From Arkaroola Bore, Flinders Ranges, and near Bimbowrie, South Australia.

Name: For the early-noted occurrence in the Il'men Mountains, Russia.

References: (1) Palache, C., H. Berman, and C. Frondel (1944) Dana's system of mineralogy, (7th edition), v. I, 534–541. (2) Deer, W.A., R.A. Howie, and J. Zussman (1962) Rock-forming minerals, v. 5, non-silicates, 28–33. (3) Ashwal, L.D. (1982) Mineralogy of mafic and Fe–Ti oxide-rich differentiates of the Marcy anorthosite massif, Adirondacks, New York. Amer. Mineral., 67, 14–27. (4) Wechsler, B.A. and C.T. Prewitt (1984) Crystal structure of ilmenite ($FeTiO_3$) at high temperature and at high pressure. Amer. Mineral., 69, 176–185. (5) Ohgaki, K., M. Ohgaki, K. Tanaka, F. Marumo, and H. Takei (1989) Electron-density distribution in ilmenite-type crystals, IV. Iron (II) titanium (IV) trioxide, $FeTiO_3$. Mineral. J. (Japan), 14, 179–190. (6) (1978) NBS Mono. 25, 15, 34.