Ullmannite NiSbS

Crystal Data: Cubic. *Point Group:* 23. As cubes and, less commonly, octahedra, pyritohedra, tetrahedra, to 3 cm. Cube faces striated by [110], twin boundaries of enantiomorphs. *Twinning:* Forms penetration twins about [110] with {001} the approximate composition plane; re-entrants develop on cube edges.

Physical Properties: *Cleavage:* Perfect on {001}. *Fracture:* Uneven. *Tenacity:* Brittle. Hardness = 5–5.5 VHN = 592–627 (100 g load). D(meas.) = 6.65 ??6.85 D(calc.) = 6.793

Optical Properties: Opaque. *Color:* Steel-gray to silver-white; white in reflected light. *Streak:* Grayish black. *Luster:* Metallic. *Anisotropism:* Individuals may be weakly anisotropic revealing a fine lamellar structure.

R: (400) 52.0, (420) 51.0, (440) 50.0, (460) 49.0, (480) 48.2, (500) 47.4, (520) 46.7, (540) 46.1, (560) 45.7, (580) 45.5, (600) 45.5, (620) 45.6, (640) 46.0, (660) 46.4, (680) 47.0, (700) 47.6

Cell Data: *Space Group:* $P2_13$ ($P1$ for arsenian ullmannite). $a = 5.88$–5.93 $Z = 4$

X-ray Powder Pattern: Salchendorf, Germany.
2.64 (100), 1.774 (70), 2.40 (60), 1.573 (50), 1.092 (50), 0.810 (50), 0.802 (50)

Chemistry:

	(1)	(2)	(3)	(4)
Ni	28.91	27.3	23.3	27.62
Co	1.13	0.8	3.8	
Fe	0.40			
Sb	42.93	52.8	58.9	57.29
As	10.28	3.5	0.4	
Bi	0.68	1.0		
S	16.22	15.1	14.8	15.09
Total	100.55	100.5	101.2	100.00

(1) Gosenbach, Germany. (2) Petersbach mine, Germany; by electron microprobe. (3) Broken Hill, Australia; by electron microprobe. (4) NiSbS.

Polymorphism & Series: Forms a series with willyamite.

Mineral Group: Cobaltite group.

Occurrence: With nickel minerals in hydrothermal veins.

Association: Nickeline, gersdorffite, pentlandite, chalcopyrite, pyrrhotite, galena, tetrahedrite, dyscrasite.

Distribution: In Germany, in North Rhine-Westphalia, from [Freusburg [spelling OK = mindat.org, but see notes??], near Siegen?? ck USNM catalog??]; at the Friedrich mine, near Wissen; the Petersbach mine, near Eichelhardt; Gosenbach; Salchendorf; and at Ramsbeck; in the Harz Mountains, from Neudorf; and elsewhere From Lölling, Carinthia, Austria. In France, at Ar, near Eaux-Bonnes, Pyrénées-Atlantiques. From Monte Narba and Masaloni, Sarrabus, Sardinia, Italy. In the Settlingstones mine, Fourstones, Northumberland, and at New Brancepeth colliery, Durham, England. From the Talnakh area, Noril'sk region, western Siberia, Russia. In the Esperanza mine, Salta Province, Argentina. In Canada, at the Kerr Addison mine, Timiskaming district, Ontario; and from the Nicholson mine, near Goldfields, Saskatchewan. At Broken Hill, New South Wales, Australia. In the Champion Reef mine, Kolar Gold Fields, Karnataka, India. Dozens of additional minor localities are known.

Name: In honor of Johan Christoph Ullmann (1771–1821), German chemist and mineralogist, who first discovered the mineral.

References: (1) Palache, C., H. Berman, and C. Frondel (1944) Dana's system of mineralogy, (7th edition), v. I, 301–302. (2) Bayliss, P. (1986) Subdivision of the pyrite group, and a chemical and X-ray diffraction investigation of ullmannite. Can. Mineral., 24, 27–33. (3) Takéuchi, Y. (1957) The absolute structure of ullmanite, NiSbS. Mineral. J. (Japan), 2, 90–102. (4) Berry, L.G. and R.M. Thompson (1962) X-ray powder data for the ore minerals. Geol. Soc. Amer. Mem. 85, 95–96.