79.0° was obtained. (Swarts[17] reports 74°.) Anhydrous ammonia was passed into the CCl_4 solution of the ester to give the amide $CFHICONH_2$ melting at 93.0° (Swarts reports 92.5°).

Infrared spectra were taken with a Perkin–Elmer Model 12 C spectrophotometer. A Beckman quartz spectrophotometer, Model D.U., was used for the ultraviolet spectrum.

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BOULDER, COLORADO

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[17] F. Swarts, "Organic Fluorine Compounds: A Review," Mem. Couronnes, *Acad. roy. Belg.*, **61**, 94 (1901); *Chem. Zentr.*, **74**, 12 (1903).

[CONTRIBUTION FROM LOS ALAMOS SCIENTIFIC LABORATORY OF THE UNIVERSITY OF CALIFORNIA]

Preparation and Some Properties of $HAu(CN)_2$[1]

BY R. A. PENNEMAN, E. STARITZKY AND L. H. JONES

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The existence of $HAu(CN)_2$ has been suggested in the literature, for example, in the work of Bassett and Corbet[2] on $KAu(CN)_2$, but the compound was not isolated. The preparation of a dilute solution (10^{-3} *M*) of the analogous compound, $HCu(CN)_2$, by the dissolution of CuCN in aqueous HCN has been reported.[3] These workers found that $HCu(CN)_2$ behaved like a strong acid, having the limiting equivalent conductance, Λ_∞ 389.

Our interest in $HAu(CN)_2$ arose from a discussion[4] concerning work of L. H. Jones on the polarized infrared spectrum of $KAu(CN)_2$.[5]

Experimental

The preparation of $HAu(CN)_2$ is achieved readily by passage of a solution containing $KAu(CN)_2$ through a column containing H^+-form Dowex-50 resin. In a typical experiment, 1 g. of $KAu(CN)_2$ was dissolved in 15 ml. of water and passed slowly through a resin column (1.5 cm. i.d. × 13 cm.), previously washed to *p*H 6 with water. When $HAu(CN)_2$ appeared in the eluate, the *p*H dropped abruptly.

A purer preparation (containing only negligible AuCN) was obtained when a saturated solution containing equivalent amounts of $KAu(CN)_2$ and KCN was passed through the resin so that both $HAu(CN)_2$ and HCN were produced. Under these conditions, less decomposition occurred when the solution was evaporated.

Colorless crystals of $HAu(CN)_2$ were deposited when a drop of solution was evaporated rapidly in a stream of dry air at room temperature. A microchemical test for potassium was negative. $HAu(CN)_2$ is readily soluble in water. If the solid is heated to 120° it alters rapidly, forming AuCN; decomposition is slower at 103°.

Preparations were examined with the polarizing microscope, with infrared spectroscopy and by X-ray.

The crystals of $HAu(CN)_2$ examined were small, had poorly developed faces, and gave irregular extinctions in crossed polarized light. Observed extinction angles and interference figures make it probable that $HAu(CN)_2$ crystallizes in the monoclinic system. The crystals are optically biaxial positive with a large axial optic angle (estimated $2V_Z = 70°$) and with very strong dispersion of optic axes $r > v$. The principal refractive indices are $n_X = 1.95$; $n_Z = 1.96$; $n_3 = 1.98$.

The infrared spectrum of an aqueous solution of $HAu(CN)_2$ has a strong absorption peak at 2147 cm.$^{-1}$, as does aqueous $KAu(CN)_2$. A sample of solid $HAu(CN)_2$, dried on polythene film, showed absorption bands at 2146 and 399 cm.$^{-1}$. Neither the bending frequencies nor a hydrogen stretching frequency for solid $HAu(CN)_2$ were observed at path lengths up to 0.5 mm. Thicker samples were too opaque to infrared radiation to obtain their spectra. Solid $KAu(CN)_2$ shows absorption peaks at 2141 and 427 cm.$^{-1}$ (see reference 5). These peaks correspond to the asymmetric C–N stretching and asymmetric C–Au–C stretching vibrations, respectively. This indicates that probably the Au–C force constant is lower in solid $HAu(CN)_2$ than in solid $KAu(CN)_2$. In solid $KAu(CN)_2$ the peak at 2141 cm.$^{-1}$ has a much higher extinction coefficient than the analogous peak of solid $HAu(CN)_2$ at 2146 cm.$^{-1}$. This indicates that although $HAu(CN)_2$ is highly ionized to H^+ and $Au(CN)_2^-$ in aqueous solution, in the solid it is probably essentially un-ionized, thus greatly decreasing the extinction coefficient.

A sample of $HAu(CN)_2$ gave a powder X-ray diffraction pattern in which no lines characteristic of $KAu(CN)_2$ or of AuCN were recognized (see Table I). After 20 minutes heating at 120° in the open capillary, the residue gave an X-ray diffraction pattern characteristic of AuCN and no other recognized lines.

TABLE I

PARTIAL POWDER X-RAY DIFFRACTION PATTERN OF $HAu(CN)_2$

d (A.)[a]	I/I_1[b]	*d* (A.)[a]	I/I_1[b]
8.67	100	2.286	5
4.76	<5	2.160	10
4.49	<5	1.921	<5
4.36	<5	1.745	5
4.30	30	1.729	5
3.35	<5	1.618	<5
3.02	45	1.510	5
2.94	<5	1.441	5
2.88	20	1.392	<5
2.70	5		

[a] Philips 114.6 mm. diameter powder camera, Straumanis mounting ($CuK\alpha$) = 1.5418 A. [b] Relative peak intensities above background from densitometer measurements.

LOS ALAMOS, NEW MEXICO

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[1] This work was sponsored by the United States Atomic Energy Commission.

[2] H. Bassett and A. S. Corbet, *J. Chem. Soc.*, **125**, 1660 (1924).

[3] M. G. Vladimirov and I. A. Kakovsky, *Zhurnal Prikladnow Chimii* (*Journal of Applied Chemistry*), **23**, (6) 580 (1950).

[4] Prof. John C. Bailar, Jr., University of Illinois suggested $HAu(CN)_2$ while consulting at LASL.

[5] L. H. Jones, *J. Chem. Phys.*, **22**, 1135 (1954); **21**, 1891 (1953).