K X-Ray Spectrum of Hg

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Wavelength values are given for 9 lines in the *K* x-ray spectrum of mercury as measured with a bent-crystal spectrometer. The high luminosity has made it possible to use only 15 watts loading of the x-ray tube, thus preventing too rapid evaporation of mercury from the silver-amalgam anticathode.

ONLY a few measurements of the *K* x-ray spectrum of Hg have been made because of the great difficulties in obtaining a good anticathode. Photographic registration requires a large intensity with accompanying high loading of the x-ray tube and rapid evaporation of the mercury.

Barrère,[1] using a Hg-contaminated Au-anticathode, gives the wavelength values of a few *K* lines. Unfortunately, however, most of the Hg lines coincide with Au *K* lines, therefore being impossible to detect. Smither and co-workers[2] report the energy value 70.70 kev for Hg $K_{\alpha 1}$ measured during the investigation of the capture gamma-ray spectrum of gold, using the 7.7-meter bent-crystal spectrometer of the Argonne National Laboratory.

During an investigation of the *K* lines of heavier elements in our laboratory it proved possible to detect the total *K* x-ray spectrum of Hg emitted from a silver amalgam anticathode when the x-ray tube was operated at low power. The spectrometer used was a 2.5-meter focusing bent-crystal spectrometer of the transmitting type utilizing the $22\bar{4}3$ plane of quartz. The rays from the anticathode were focused on a slit, 0.1 mm wide, in front of a NaI scintillation counter. The slit and counter could be moved by a precision screw, thus exploring the spectrum point by point. A detailed description of the spectrometer is given in an earlier paper.[3]

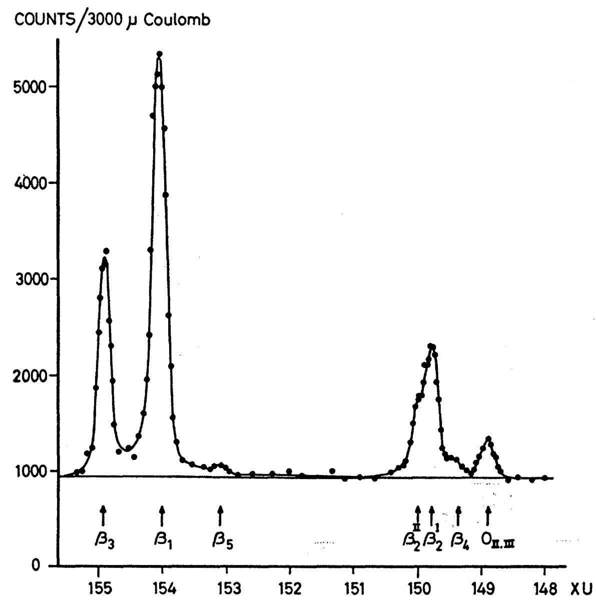

FIG. 1. General view of the β lines of Hg *K* x-ray spectrum.

The 800-kv van de Graaff generator of the Institute served as voltage source for the x-ray tube. By using a high voltage (600 kv) it was possible to get a large peak-to-background ratio of the lines (see Fig. 1). Higher orders of the continuous spectrum were discriminated against by the use of a single-channel pulse-height analyzer in connection with the scintillation counter. Further, the great sensitivity of the counter and the high luminosity of the spectrometer ensured enough counting rate for electron beams of only 20–30 μa. The heating effect in the focal spot was only about 1 watt/mm^2, which explains the successful use of a silver amalgam anticathode. As to the preparation of the anticathode, powdered silver was amalgamated with mercury in excess. After pressing out the excess mercury the amalgam was packed in a depression in a copper plate, forming a 0.5-mm thick amalgam plate. The high vacuum in the accelerating tube was 10^{-5} mm Hg with beam off, rising to about 10^{-4} mm Hg with beam on. The decrease in intensity of the spectrum due to evaporation of the mercury during the measurements, which lasted for 12 hours, amounted to only 20%.

The wavelength values were determined relative to the strongest lines in the *K* x-ray spectrum of Au, measured by Ingelstam.[4] The values together with Barrère's values are quoted in Table I. For transforming wavelength to energy the value $E\lambda_s = 12372.44$ kev x units of DuMond and Cohen[5] was used. The wavelength values have an estimated error of 0.05 x units.

TABLE I. Wavelength values and relative intensities of the *K* x-ray lines of Hg.

Line	Beckman x units	Beckman kev	Int.	Barrère x units
α_2	179.56	68.903	51.0	(179.8)
α_1	174.69	70.825	100.0	174.7±0.15
β_3	154.92	79.862	13.1	
β_1	154.08	80.298	26.6	
β_5	153.13	80.796	0.72	153.1±0.2
β_2^{II}	150.00	82.482	10.0 (both β_2)	149.9±0.2
β_2^{I}	149.79	82.597		
β_4	149.4	82.83		
$O_{II,III}$	148.90	83.091	1.8	

[1] G. Barrère, Compt. rend. **233**, 376 (1951).
[2] Smither, Hamermesh, and Rose, Bull. Am. Phys. Soc. Ser. II, **2**, 55 (1957).
[3] O. Beckman, Arkiv Fysik **9**, 495 (1955).
[4] E. Ingelstam, "Die *K*-Spektren der Schweren Elemente," No. 5. Nova Acta Reg. Soc. Sci., Uppsala (1937).
[5] E. R. Cohen and J. W. M. DuMond, *Encyclopedia of Physics*, edited by S. Flügge (Springer-Verlag, Berlin, 1957), Vol. 35, p. 1.