Gamma Spectrum of Rhodium-106 (130 ± 2 min)

By S. Mayo and S. J. Nassiff*

The reactions Pd^{108}(d, α)Rh^{106}, Pd^{106}(n, p)Rh^{106} and Ag^{109}(n, α)Rh^{106} (Ref. 1) showed β activity with a half-life of 117 minutes and a maximum energy, as measured by absorption, of 700 kev, which was ascribed to Rh^{106m}.

W. E. Nervik and G. T. Seaborg,[2] by bombarding Ta and U with 340-Mev protons, obtained rhodium with a half-life of 136 minutes, to which the mass number of 107 was given as probable, and for which a few γ energies were measured.

Aside from the reactions given in Ref. 1, we have carried out a systematic study of the γ spectrum of this nuclide, giving a half-life of 130 ± 2 minutes on all its radiation. Observation of some energies indicated that, in its half-life scheme, there might be some levels common to those encountered[3–6] in the disintegration of Rh^{106} and Ag^{106} to Pd^{106}, which would suggest that mass number 106 is the most probable for this nuclide.

EXPERIMENTAL

Rh^{106}(130 ± 2 min) was obtained by either irradiating Pd with 28-Mev deuterons or Ag with neutrons from the Be(d, n)B reaction. Chemical separation was achieved by precipitation as $Rh(NO_2)_6K_3$.

In the irradiation with neutrons, the silver was dissolved in nitric acid which contained 30 mg of the Rh ion and 10 mg of the Pd ion. The silver was precipitated with potassium chloride several times until active silver was eliminated from the solution. In the filtrate, Rh was precipitated as potassium rhodiohexanitrite, which was dissolved in order to be reprecipitated in the presence of 10 mg of the Pd ion. This purification was repeated twice.

For the investigation of γ energies up to 1 Mev, work was conducted with a scintillation spectrometer with a 1 inch crystal.[7] For higher energies a NaI(Tl) crystal 1.5 in. by 1.5 in. was used. The equipment was calibrated for energy and efficiency with Hg^{203}, Na^{22}, Cs^{137}, Zn^{65}, Y^{88} and Na^{24}. For a distance of 7 mm between the front and the crystal, the efficiency was 3% for the 2.38-Mev line of Na^{24}. Figures 1 and 2 show the spectra of Rh^{106}(130 ± 2 min) corresponding to the two crystals used. The half-life was investigated for all γ rays, giving a value of $T_{\frac{1}{2}} = 130 \pm 2$ min. Figure 3 shows the relevant 515-kev half-life.

In order to obtain the relative intensities of the γ rays of Rh^{106}(130 ± 2 min) the Compton background was discounted in the customary fashion.[8] For the high energies, a similar method was pursued with the background due to the annihilation radiation coming from the formation of pairs in the crystal. Table 1 shows our results and those of Ref. 2.

DISCUSSION

Gamma rays of 1380 kev and 940 kev energy only appear when the Compton background is discounted, so that their existence is dubious. The area from 600 to 800 kev corresponds to the annihilation radiation from the formation of pairs in the crystal by γ rays

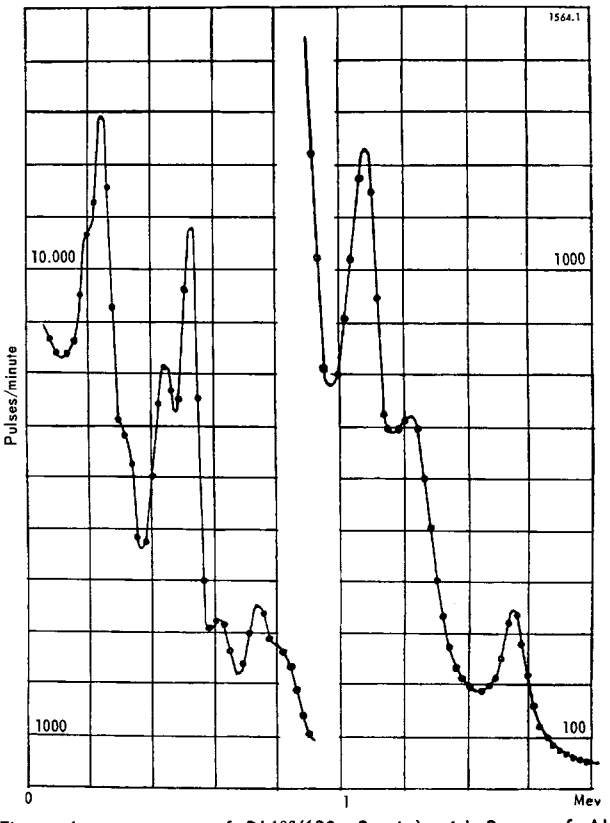

Figure 1. γ spectrum of Rh^{106}(130 ± 2 min) with 2 mm of Al between the source and the crystal (1 in. × 1 in.) corrected for the decay time

Original language: Spanish.

* Comisión Nacional de Energía Atómica, Buenos Aires.

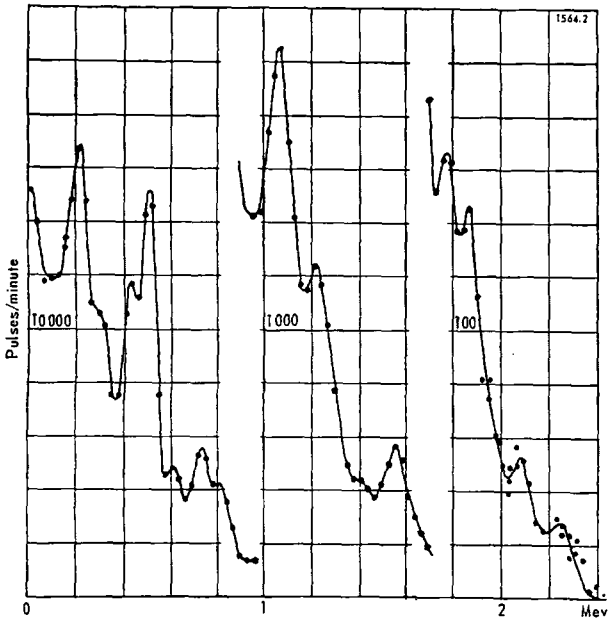

Figure 2. γ spectrum of Rh^{106}(130±2 min) with 2 mm of Al between the source and the crystal (1.5 in. × 1.5 in.) corrected for the decay time

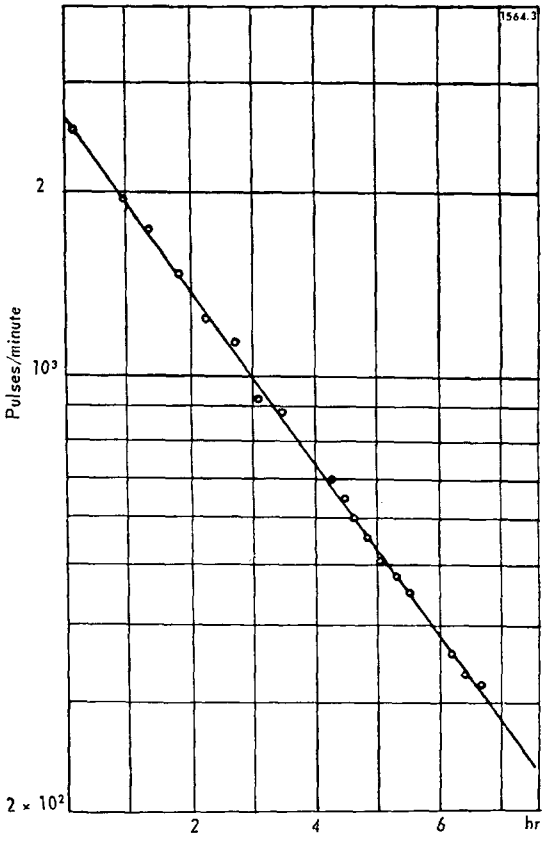

Figure 3. Half-life of the 515-kev γ ray of Rh^{106}

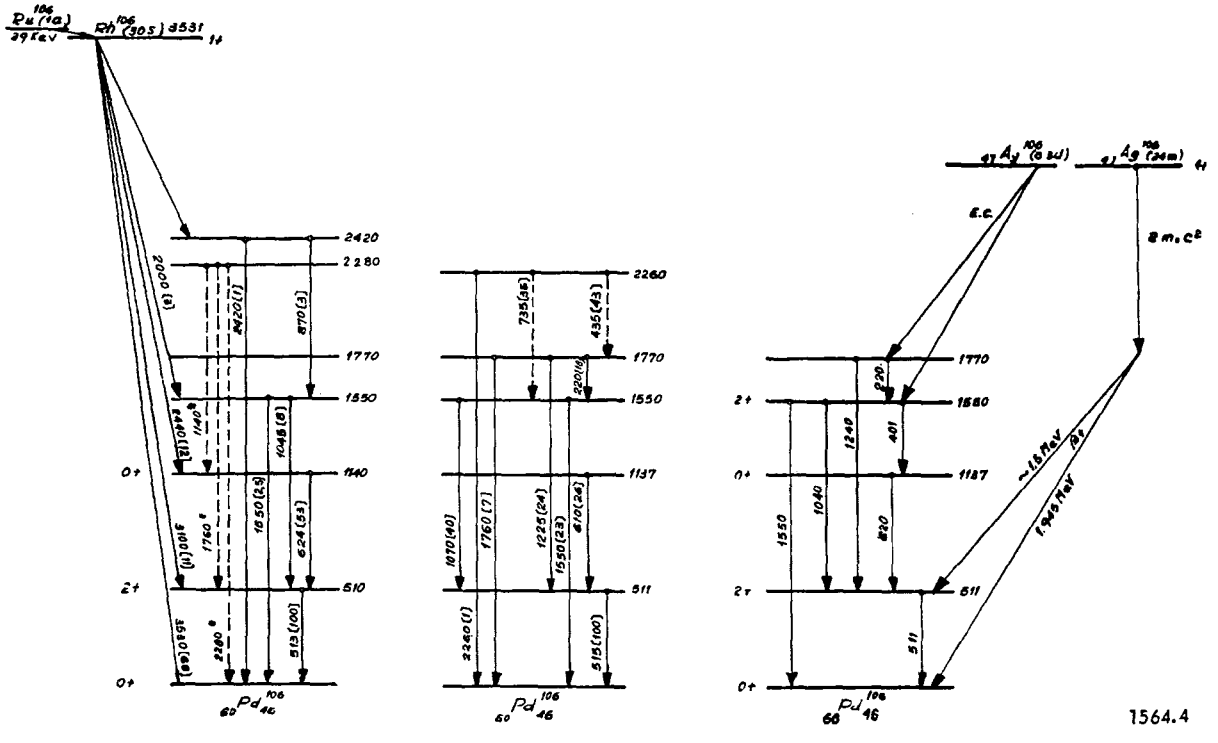

Figure 4. Disintegration scheme of Rh^{106} and Ag^{106}

Table 1

Ref. 2, $T_{\frac{1}{2}}$=136 *min*		*Present authors,* $T_{\frac{1}{2}}$=130±2 *min*		
			Intensity, %	
E, kev	*Intensity, %*	*E, kev*	*Crystal 1×1 in.*	*Crystal 1.5×1.5 in.*
195	—			
225	—	220±5	17	19
		435±5	40	45
510	—	515±5	100	100
630	—	610±5	22	30
715	—	735±5	34	39
		820±5	41	50
		940±10?	?	?
1060	—	1070±5	38	41
1200	—	1225±5	20	27
1260	—	1380±10?	?	?
1500	—	1555±5	22	23
		1760±10		7
		1860±10		8
		2090±10		
		2260±10		1

of more than 1.03 Mev energy. Because of this the intensities of 820-kev, 735-kev and 610-kev rays have not been determined better.

The spectrum shows an energy peak corresponding to 315 kev, which we ascribe to Rh^{105} since its half-life is 36.5 hours. The 220-kev, 435-kev, 1760-kev, 610-kev, 1225-kev and 1555-kev rays were observed in the disintegration of Ag^{106} by electron capture.[6]

Rays of 735 kev and 820 kev can be compared with those of 717 kev and 815 kev due to the disintegration of Ag^{106}(8.3 d).[6] Those of 515 kev, 610 kev, 1070 kev, 1555 kev, 1760 kev and 2090 kev were observed in the disintegration by negative β emission of Rh^{106}(30 sec).[3–5] All this leads one to suppose that the disintegration scheme of Rh^{106}(130±2 min) has some common levels with Rh^{106}(30 sec) and Ag^{106} (8.3 d).

The 515-kev, 1130-kev, 1555-kev, 1770-kev, and 2260-kev levels, due to disintegration of Rh^{106} and Ag^{106} to Pd^{106}, could also be easily found in the possible disintegration scheme of Rh^{106}(130±2 min) as shown in Fig. 4. This in no way implies a definite disintegration scheme but rather the possible position of some of the rays found.

We extend our thanks to Dr. H. Bosch for discussion of this work.

REFERENCES

1. G. B. Baró, W. Seelmann-Eggebert and I. E. Zabala, Z. Naturforsch., *10a*, 1 (1955).
2. W. E. Nervik and G. T. Seaborg, Phys. Rev., *97*, 1092 (1955).
3. D. E. Alburger, Phys. Rev., *88*, 339 (1952).
4. B. Kann and W. S. Lyon, Phys. Rev., *92*, 902 (1953).
5. D. E. Alburger and B. J. Toppel, Phys. Rev., *100*, 1357 (1955).
6. M. Goldhaber and R. D. Hill, Revs. Mod. Phys., *24*, 179 (1952).
7. C. A. Malmann, S. Mayo and S. J. Nassiff, Rev. Mexicana. Fis., *4*, 185 (1956).
8. H. Bosch and H. Munceck, Ciencia e Investigación, *12*, 244 (1956).