Sonderdruck aus Radiochimica Acta 2, 7–8 (1963)

The ^{189}W–^{189}Re Decay Chain

By J. FLEGENHEIMER, G. B. BARÓ, and M. VIIRSOO, Comisión Nacional de Energía Atómica, Buenos Aires, Argentina

With 4 figures. (Received March 25, 1963)

Summary ^{189}W has been found by an Os (n, α) reaction. Its half-life is 11 minutes and the maximum β energy around 1.4 MeV. A tungsten nuclide with this half-life could not be obtained with a W (d, p) reaction. The 23 hours ^{189}Re reported by CRASEMANN, EMERY, and KANE, was prepared using enriched osmium isotopes. Its maximum β energy is about 0.8 MeV and γ lines of 65, 140, 170 and 225 keV have been observed.

Zusammenfassung ^{189}W wurde als Produkt einer Os(n, α)-Reaktion gefunden. Es besitzt eine Halbwertszeit von 11 Minuten und eine maximale β-Energie um 1,4 MeV. Ein Wolframkern dieser Halbwertszeit war durch eine W(d, p)-Reaktion nicht zu erhalten. Das von CRASEMANN, EMERY und KANE angegebene 23-Stunden-^{189}Re wurde aus angereicherten Os-Isotopen hergestellt. Seine maximale β-Energie liegt um 0,8 MeV; γ-Linien wurden bei 65, 140, 170 und 225 keV beobachtet.

Résumé ^{189}W a été obtenu par la réaction Os (n, α). Il a une période de 11 minutes et une énergie β maximale d'environ 1.4 MeV. Cet isotope ne peut être obtenu par réaction W (d, p) n. Le ^{189}Re de 23 heures cité par CRASEMANN, EMERY et KANE a été préparé à l'aide d'isotopes d'asmium enrichis. Son énergie β maximale est d'environ 0,8 MeV; des raies γ de 65, 140, 170 et 225 keV ont été observés.

If natural osmium is bombarded with fast neutrons a beta emitting nuclide with an 11 minutes half-life can be detected in the tungsten fraction (Fig. 1). The only other detectable half-life in the decay curve is 24 hours, corresponding to ^{187}W. With our neutron energies—beryllium was bombarded with 28 MeV deuterons in the synchro-cyclotron—the yield of the 24-hours nuclide is roughly equal the yield of the 11 minutes nuclide.

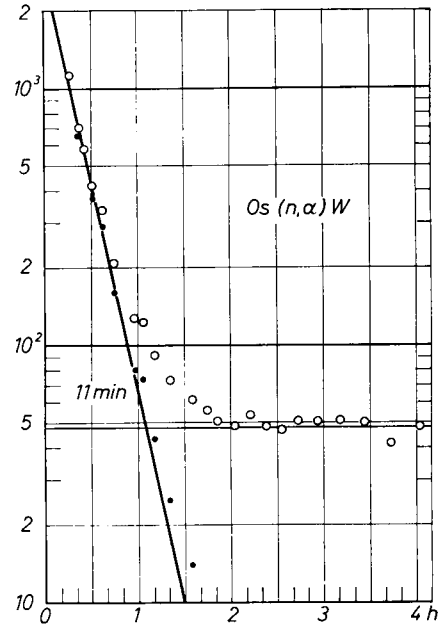

Fig. 1. Decay of the activity of the tungsten fraction (after chemical separation) produced by irradiation of natural osmium with fast neutrons. The 11-minutes period is due to ^{189}W, the long period is the 24-hours period of ^{187}W

^{189}Re was prepared by bombarding enriched osmium isotopes obtained from Oak Ridge. On bombarding ^{192}Os (98.68% pure) with 28 MeV deuterons the rhenium fraction after chemical separation shows the presence of 2.8-hour ^{190}Re and a 24-hour half-life [1] (Fig. 2). Chemically separated rhenium from the same enriched ^{192}Os bombarded for many hours with fast neutrons showed only a 25-hours half-life. The gross beta decay curves of enriched ^{189}Os (87.3%) and of the rhenium fraction from natural osmium bombarded with fast neutrons are more difficult to analyze due to the presence of ^{188}Re with a similar half-life. In the rhenium fraction of iridium bombarded with fast

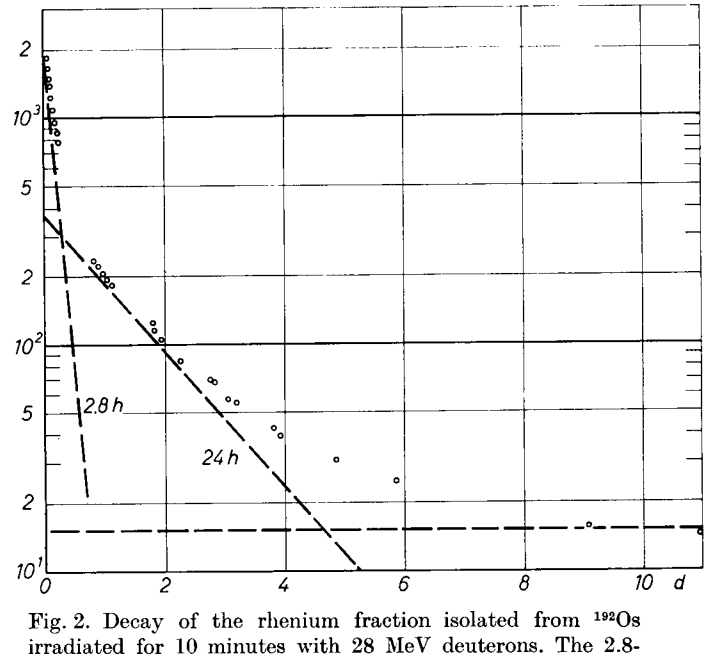

Fig. 2. Decay of the rhenium fraction isolated from ^{192}Os irradiated for 10 minutes with 28 MeV deuterons. The 2.8-hours period is due to ^{190}Re, the 24-hours period to ^{189}Re

neutrons the 22–25-hours half-life is not observed (Fig. 3).

Repeated milking of rhenium from the tungsten fraction produced by (n, α) reaction was not possible

1. G. B. BARÓ and J. FLEGENHEIMER, Radiochim. Acta **1**, 2 (1962).

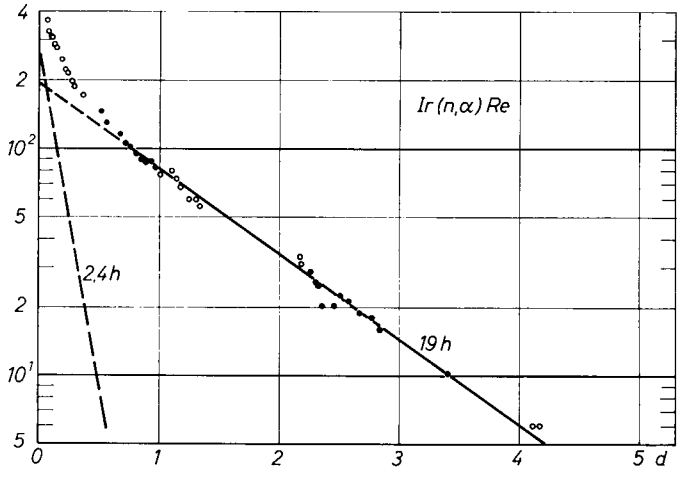

Fig. 3. Decay of the rhenium fraction isolated from iridium irradiated for 30 minutes with fast neutrons. The 2.4-hours period is due to ^{190}Re and the 19-hours period to ^{188}Re. The 23-hours period of ^{189}Re is not observed

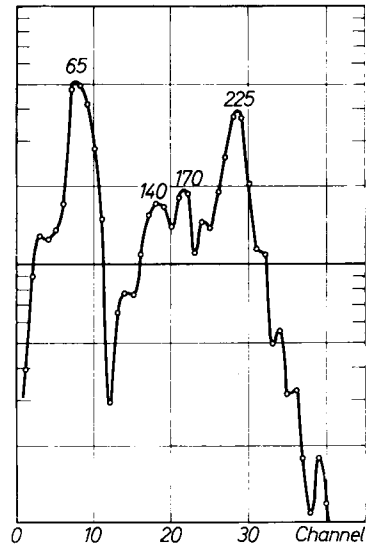

Fig. 4. Scintillation spectrum of 23-hours ^{189}Re

due to low activities. However, when rhenium was chemically separated from tungsten after decay of the 11 minutes nuclide, the small activity observed agreed in amount and half-life with a decay of the 11 minutes tungsten to the 22–25 hours rhenium.

For deuteron bombardments, enriched ^{192}Os was irradiated as the metal and dissolved by means of VAN DER WIEL's technique [2]. After the addition of carriers the osmium was recovered by nitric acid distillation. The rhenium fraction was distilled after adding sulphuric acid, precipitated with tetraphenylarsonium chloride and redistilled. For neutron irradiations, ^{192}Os and natural osmium were used as the hydrated dioxides. The rhenium fraction was extracted by ammonia-H_2O_2 treatments as described before for iridium oxide [1]. The rhenium fraction was generally purified by one or more distillations. In the case of the osmium (n, α) reaction, after carrier addition, the osmium was repeatedly distilled off from nitric and sulphuric acid. Tungstic acid was filtered through a glass filter, dissolved in ammonia and rhenium was precipitated and filtered together with ferric hydroxide. Tungstic acid was precipitated from the solution by adding nitric acid. Both our osmium and iridium starting materials showed negligible impurities spectrographically.

Decay and absorption curves were taken with an end-window GM counter of about 2 mg/cm^2 window thickness. The 11-minutes tungsten nuclide and the about 23-hours rhenium nuclide show maximum beta energies of 1.4 MeV $\pm$ 0.3 MeV and 0.8 MeV $\pm$ 0.3 MeV respectively. Due to low activities these values were obtained from the half-thickness values of the absorption curves taken with aluminium absorbers in a calibrated arrangement.

The gamma rays of the 23-hours rhenium isotope were observed with a single sliding channel spectrometer with a $2'' \times 2''$ sodium iodide crystal as detector. The rhenium sample came from a deuteron bombardment of ^{192}Os and was purified by a double distillation. After decay of the 2.8 hours ^{190}Re, gamma rays of 65, 140, 170 and 225 keV were found, in partial agreement with values for ^{189}Re of CRASEMANN et al. [3]. No 11-minutes tungsten nuclide was found after a $W(d, p)$ reaction, which excludes mass numbers 185 and 187. We therefore assign the mass number 189 to this half-life. Since the 23-hours rhenium nuclide was produced by fast neutrons on ^{190}Os and 28 MeV deuterons on ^{192}Os, as well as by fast neutrons on ^{192}Os, its formation can be explained by an (n, np) reaction, a $(d, \alpha n)$ reaction and decay of ^{189}W formed by an (n, α) reaction respectively. Other facts agree with an assignment of mass number 189 to this half-life, confirming CRASEMANN et al's mass number determined by cross-bombardments [3].

Acknowledgements

We wish to thank Dr. SANTOS MAYO and the personnel of the synchro-cyclotron for the irradiations. Financial assistance from the Consejo Nacional de Investigaciones Científicas y Técnicas is gratefully acknowledged. We thank Prof. W. SEELMANN-EGGEBERT for chemical assistance.

2. A. VAN DER WIEL, Chem. Weekbl. **48**, 597 (1952).

3. B. CRASEMANN, G. T. EMERY and W. R. KANE, Bull. Amer. Physic. Soc. II. **7**, 353 (1962).

Note added in proof: A more complete study of ^{189}Re has now become available (B. CRASEMANN, G. T. EMERY, W. R. KANE, and M. L. PERLMAN, BNL-6879, March 29, 1963). The gamma spectrum has been studied in detail. The maximum beta energy found is 1.0 MeV, which agrees within the limits of error with our value.