formed by any means at our disposal, even when inoculated with grey tin powder. This was not the result of extreme purity, for (1) addition of various impurities to the sample failed to make it transformable, and (2) after the sample had been heated in a vacuum at 1,000° C. it could be transformed to grey tin with remarkable rapidity. We can only assume that this batch of tin was contaminated with a minute trace of some impurity which was removed by fractional distillation. A very small amount of sublimate was, in fact, collected; but no unusual material was identified in it. It seems remarkable and is perhaps of practical importance that so small an amount of matter can suppress the transformation entirely; but, whatever the explanation, the experiments have been repeated too often to leave room for doubt on the observations.

Arising out of this work, we have used the allotropic transformation to prepare white tin powder free from oxide. A bar of white tin, on which a few particles of grey tin are sprinkled, is sealed in an evacuated glass tube, which is then stored in solid carbon dioxide. After about forty-eight hours the tube is found to contain only grey tin powder, which can be converted to white tin powder by heating the tube in warm water. The particles of white tin formed in this way can have had no effective contact with gases and may be useful for certain investigations. We have used such material in special studies of the powder metallurgy of tin.

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Search for Beryllium-7 in Uranium Fission

Two types of ternary fission of uranium are known. In the first[1], two heavy fragments and a lighter particle of an average range 20–30 cm. in air are observed with a frequency of about 0·3 per cent of normal fission. The light particle is generally believed to be an α-particle; but Tsien *et al.* have suggested[2], from investigations using the photographic plate technique, that the mass may vary from 4 to 9. There is also some evidence[3] for the occurrence of beryllium-8. In the second type of ternary fission, two heavy particles and one light one with a range of about 8 mm. in air are observed[4,5], occurring to the extent of 1·3 per cent of binary fission. The light fragments are considerably more massive than α-particles and a mass of 13 ± 4 has been very tentatively suggested[5].

The isotope in the mass range 4–9 most suitable for a radiochemical investigation of the light particles is beryllium-7 with a half-life of 52·9 days[6]. Although it is on the neutron-deficient side of nuclear stability, unlike any of the known fission products, it was considered worth while to search for beryllium-7 in neutron-bombarded uranium.

A quantity of 50 gm. of uranium oxide which had been in the pile for three months was dissolved in nitric acid, about 100 mgm. of beryllium as nitrate added, the solution concentrated by evaporation and the majority of the uranyl nitrate removed by extraction with methyl *iso*butyl ketone. The residual aqueous solution was then treated with excess potassium hydroxide, which formed soluble potassium beryllate and insoluble potassium uranate. The solution was filtered and acidified with nitric acid, and beryllium hydroxide precipitated by addition of ammonia. Insoluble sulphide impurities were removed by three scavengings with a mixture of antimony and tellurium sulphides (approximately 15 mgm. of each). After boiling to remove hydrogen sulphide, about 15 mgm. of iron was added and precipitated as hydroxide in the cold with caustic soda to absorb impurities forming insoluble hydroxides. The precipitate was centrifuged, the mother liquors acidified and beryllium hydroxide precipitated by addition of ammonia. After washing the precipitate, it was dissolved in dilute acetic acid and the solution evaporated to near dryness, when 5 ml. of glacial acetic acid was added and the solution again evaporated. The basic beryllium acetate so formed[7] was extracted by several washes with chloroform. The organic solution was then washed with 0·5 *N* nitric acid solution and with water, the washings being rejected. The beryllium was recovered by evaporation of the chloroform and solution of the residue in hydrochloric acid. As a small amount of γ-activity was detected by a γ-scintillation counter, the formation and extraction of basic beryllium acetate was repeated, after which the beryllium was found to be inactive.

Assuming that 20 c./min. of beryllium-7 could be detected above the rather high background of the counter and that 11 per cent of the beryllium-7 disintegrations emit a 0·48-MeV. γ-ray[8], a limit to the fission yield was set from the known efficiency of the γ-counter, the chemical yield of beryllium, etc.; and the number of fissions was determined from the amount of barium-140 in suitable aliquots of the original solution. An upper limit of 2×10^{-5} per cent was obtained.

The experiment was repeated using 100 gm. of uranium metal irradiated for one year. A similar chemical procedure was employed, except that sodium uranate was used as a scavenging agent instead of ferric hydroxide, and the number of chloroform extractions of basic beryllium acetate was increased. No γ-activity above background could be detected in the beryllium fraction. In this case, using the same assumptions as before, the upper limit obtained for the fission yield was 10^{-5} per cent. Thus, assuming that ternary fission of the first type occurs to the extent of 0·003 of that of binary fission[1], less than one beryllium-7 nucleus is produced in 3×10^4 ternary fissions of the first type and less than one in $1{\cdot}3 \times 10^5$ of the second type.

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[1] Allen, K. W., and Dewan, J. T., *Phys. Rev.*, **80**, 181 (1950); this paper also gives a bibliography.
[2] Tsien, Ho, Chastel and Vigneron, *J. Phys. et le Rad.*, **8**, 165, 200 (1947). *C.R. Acad. Sci., Paris*, **223**, 986, 1119 (1946); **224**, 272 (1947).
[3] Goward, F. K., Titterton, E. N. T., and Wilkinson, J. J., *Nature*, **164**, 661 (1949).
[4] Cassels, J. M., Dainty, J., Feather, N., and Green, L. L., *Proc. Roy. Soc.*, A, **191**, 428 (1947). Green, L. L., and Livesey, D., *Phil. Trans.*, A, **241**, 232 (1948).
[5] Allen, K. W., and Dewan, J. T., *Phys. Rev.*, **82**, 527 (1951).
[6] Segrè, E., and Wiegand, C. E., *Phys. Rev.*, **75**, 39 (1949).
[7] Noyes, A. A., and Bray, W. C., "Qualitative Analysis for the Rarer Elements" (Macmillan, 1927).
[8] Williamson, R. M., and Richards, H. T., *Phys. Rev.*, **76**, 614 (1949). Turner, C. M., *Phys. Rev.*, **76**, 148 (1949).