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ABSTRACT

Mechanically stable plutonium foils have been deposited on uranium and tungsten carbide by distillation from zirconium nitride crucibles. Fabrication of the zirconium nitride refractory is described.

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FABRICATION OF PLUTONIUM FOIL BY DISTILLATION OF THE METAL

Investigation of the feasibility of fabrication of plutonium foils by high vacuum evaporation was undertaken when the thin-liner implosion gadget was under serious consideration.

Evaporations were carried out from crucibles of cerium sulfide, zirconium nitride, and tantalum. The condensations were made on discs of uranium and tungsten carbide.

Refractories

Cerium sulfide, although it is an excellent refractory for melting and casting of plutonium, turned out to be unsuitable for evaporation; the evaporation rate was much lower than had been anticipated. Evidently a thin coating which impedes the evaporation is formed over the molten plutonium.

Metallic tantalum, on the other hand, although it gave a satisfactory rate of evaporation[1)] was not suitable because of the tendency of molten plutonium to crawl all over the crucible, outside as well as inside, and evaporate in other than the intended direction.

Zirconium nitride seemed to suffer from neither of the above difficulties. The molten plutonium remained inside the crucible and the evaporation rate corresponded to the reported vapor pressures of plutonium metal. Since the method used for fabrication of these crucibles seems somewhat novel it will be described briefly.

A tantalum crucible is first machined to the desired shape. The crucible is then thoroughly outgassed in high vacuum at 2000° to 2400°C, partially cooled in vacuum, and finally brought to room temperature in pure helium. The crucible is removed, the cavity and lip lined with 2 or 3 mil pure ductile zirconium foil, and the assembly replaced in the vacuum system. The crucible is heated until the zirconium

1) The reported vapor pressures of plutonium were obtained from rates of effusion from tantalum furnaces. (Metallurgical Laboratory, Chicago).

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just melts (about 1950°C). Prolongation of the heating at this point must be avoided, since the zirconium alloys very readily with the tantalum. The crucible is then heated for several hours at 1700 to 1800°C in about 10 cm of pure nitrogen. Finally the nitrided assembly is heated in high vacuum at about 1800°C until the rate of evolution of gas becomes insignificant at the temperatures at which the crucible is to be used.

<u>Evaporation and Condensation</u>

The principle requirement for production of a mechanically stable film is that the condensing disc be adequately cooled. Although no accurate temperature measurements were made, it seemed that only when the temperature of the condenser was not permitted to exceed the temperature of the α-β transition (about 120°C) were mechanically stable and unbroken films obtained. Thus with adequate cooling, a strong adherent film of plutonium 0.004 inches thick was evaporated onto a 1-inch-diameter tuballoy disc. This evaporation was accomplished in about 90 minutes from a zirconium nitride crucible at 1400°C. Since no adequate method of corrosion protection was available, the deposit deteriorated after a few days exposure to air.

Formation of an adherent film on cobalt-bonded tungsten carbide required that the carbide surface be given the following pretreatment: A thin coat of copper was evaporated on the carbide surface; the carbide with its copper coat was then heated in high vacuum to 900° for about one minute. The surface formed in this way accepted an evaporated coating of plutonium.

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