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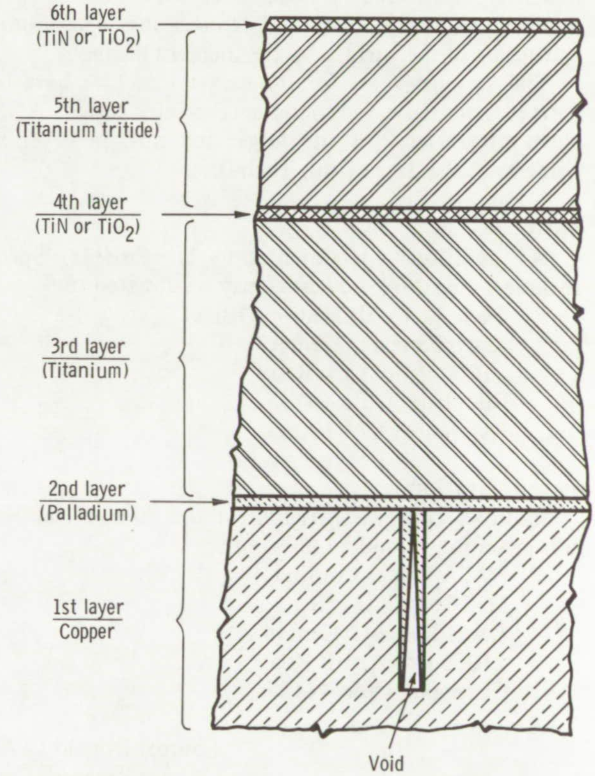
Long Life Neutron Generator Target Using Deuterium Pass-Through Structure

The Problem:

To develop a titanium tritide neutron generator target with a long useful life by near total conservation of the tritium. In conventional neutron generator targets, a thin film of titanium tritide on a water cooled copper substrate is generally used for production of 14 MeV neutrons by the T (d,n) reaction. An accelerated beam of deuterons, having energies from 100 to 500 KeV or higher, impinge on the target to produce neutrons. The deuterons do not pass through the target; they are implanted in the titanium and remain there. Since both tritium and deuterium are hydrogen isotopes and therefore chemically identical, the deuterons impinging into the tritide target continuously displace tritium atoms of the tritide. These tritium atoms diffuse to the surface and are lost to the vacuum system. The result is an expensive target with a useful life of only a few hours.

The Solution:

A target structure which permits all deuterons, except the one-in-a-million that interacts with a tritium atom to produce a neutron, to pass completely through the target structure and be returned to the vacuum system. Since the tritium atoms are not displaced as in conventional targets, the tritium population will remain unchanged while under deuteron bombardment. In this way, a long target life with constant neutron output is possible.



How It's Done:

The target structure consists of six layers of material as shown in the figure.

The first layer is a base copper substrate disc 0.203 cm (0.08 in) thick with parallel grooves.

The second layer is palladium deposited on the copper substrate by RF sputtering. The sputtering is done in such a way that the palladium coats the walls of the grooves and sufficient additional palladium is deposited to bridge the grooves.

The third layer is a film of titanium, vacuum deposited on the palladium. The thickness of this layer depends on the range of the deuterons of the accelerator beam for which the target is designed.

The fourth layer of titanium nitride or titanium oxide is a barrier layer against deuteron diffusion. It is applied by RF sputtering to a thickness of about 1000 angstroms.

The fifth layer is the titanium tritide target. The thickness of this layer is less than the deuteron range and depends on the energy of the deuterons of the accelerator beam; i.e., for a 300 KeV beam, the titanium tritide target thickness was about 2.5 μ meters.

The sixth layer of titanium nitride or titanium oxide is another barrier layer. It is deposited by sputtering to a thickness of approximately 500 angstroms.

(continued overleaf)

The target works in the following way. Beam deuterons pass through the sixth, fifth, and fourth layers and come to rest in the titanium third layer. The cross section for the T (d,n) reaction is such that only one deuteron out of a million interacts with a tritium atom in the fifth layer to produce a neutron. As the concentration of deuterons in the titanium layer increases, the activation energy increases. The fourth layer acts as a barrier to deuteron diffusion in that direction but deuterons will readily pass through the titanium-palladium interface since the activation energy for diffusion for the two materials is approximately the same. Deuterons can readily leave the palladium surface and return to the vacuum system through the grooves, thus passing completely through the target. (If a titanium-vacuum interface were used instead of palladium-vacuum, the deuteron could not leave the surface without the addition of energy.) The sixth layer is a barrier layer which reduces the probability of tritium escaping to the vacuum and reduces loss of tritium by sputtering of the surface by the incident beam.

The various layers for the target structure have been formed and their functions successfully tested. A complete integral test of the target has not, however, been made as of the date of this Tech Brief.

Note:

No additional documentation is available. Specific technical questions, however, may be directed to:

Technology Utilization Officer
Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio 44135
Reference: B74-10063

Patent Status:

Inquiries concerning rights for the commercial use of this invention should be directed to:

NASA Patent Counsel
Mail Stop 500-113
Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio 44135

Source: Donald L. Alger
Lewis Research Center
(LEW-11866)