(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 576 122 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
25.06.2025 Bulletin 2025/26

(21) Application number: **23218937.3**

(22) Date of filing: **21.12.2023**

(51) International Patent Classification (IPC):
G21G 1/10 *(2006.01)* ***H05H 6/00*** *(2006.01)*
G21G 1/00 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
G21G 1/10; H05H 6/00; G21G 2001/0063

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(71) Applicant: **SCK.CEN**
1160 Brussel (BE)

(72) Inventors:
- **VERWERFT, Marc**
  2610 Wilrijk (BE)
- **CEA, Andrew**
  3400 Landen (BE)

(74) Representative: **Winger**
Mouterij 16 bus 101
3190 Boortmeerbeek (BE)

(54) IODINE-131 ISOTOPE PRODUCTION

(57) A target for the production of Iodine-131 isotopes is described. The target comprises aluminum telluride particles within an aluminum matrix, the aluminum matrix being covered with an aluminum-based cladding layer.

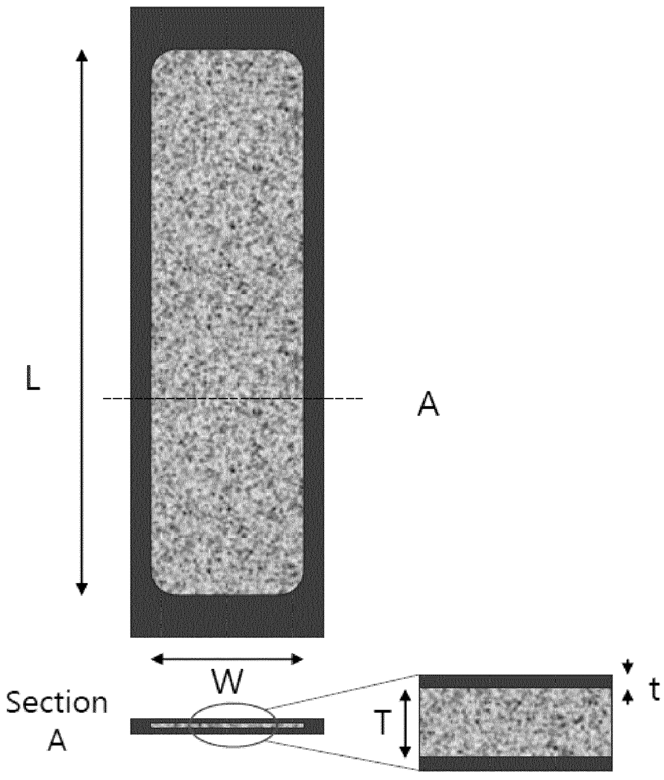


FIG. 2

Processed by Luminess, 75001 PARIS (FR)

Description

Field of the invention

[0001] The present invention relates to methods and targets for production of medical isotopes. More specifically, the present invention provides methods and targets for the production of lodine-131 isotopes, e.g. for medical imaging and for therapy.

Background of the invention

[0002] lodine-131 is used as a medical isotope, both for medical imaging and for therapy. The increased demand of this isotope from hospitals has prompted the need for additional production methods of 1-131.

[0003] From the 1960s until 1971, SCK CEN produced I-131 via the neutron irradiation of tellurium dioxide, encapsulated in a quartz ampoule and aluminum thimble tubes. The irradiation of metallic Te or TeO_2 powder in capsules has been the most used method since the beginning of I-131 production, as described in "Manual for reactor produced radioisotopes" 2003 by the International Atomic Energy Agency.

[0004] One of the downsides of lodine-131 production by irradiation of metallic Te or TeO_2, is the risk of incidents. Following a target failure in 1971, the production of I-131 was immediately halted. The target was found damaged due to excessive heating, where the burnout heat flux exceeded the upper surface limit. A significant portion of the tellurium had undergone a reduction reaction and deposits of metallic tellurium were visible. Tellurium dioxide was found to have reacted to aluminum at temperatures higher than 700°C with a strong exothermic reaction (766 kJ per mol). The use of quarts capsules was regarded as insufficient for volatile isotopes, following this incident. Quarts is in general susceptible to breaking and the reaction of tellurium and aluminum was considered too exothermic.

[0005] After the incident, I-131 was produced through the fission of uranium in medical isotope targets. First, I-131 was produced in High-Enriched Uranium (HEU) dispersion targets, whose primary purpose was for the production of molybdenum-99 (Mo-99). Mo-99, which decays to Tc-99, is used in nearly 80% of nuclear medicine diagnostics. HEU targets producing Mo-99, coproduced I-131, where Iodine is separated from the digestion solution as Iodate. Finally, in 2020, the process was converted to the use of low-enriched uranium (LEU) targets, to adapt the production to meet non-proliferation agreements.

[0006] Both HEU and LEU dispersion targets are the currently preferred method to produce medical isotopes, including I-131. Specifically, uranium aluminide dispersion-type targets (commonly referred to as UAlx or UAl_2 targets) are used for their favorable physical properties (e.g. high thermal conductivity, low neutron capture cross-section, malleable, weld and bonding properties) and chemical properties (e.g. easy to digest in acidic and basic media, easy to extract isotopes.

[0007] Both targets are on many principles the same, on a macrostructural and microstructural level. On a macroscopic level, these targets have a "fuel zone", also known as the meat, which comprises of UAl_3 and UAl_4 particles. These particles are a mix of sizes, where large particles are considered to be between 44μm and 88μm in diameter, and fine particles are considered to be less than 44μm, and where the target is expected to have around 20% of fine particles. The aluminum matrix surrounding the UAlx particles represents around 35 to 50% in volume. The UAlx particles are mixed with the aluminum and compacted into a "briquette", which eventually becomes the meat of the target. The bricket is then incased with two aluminium plates on the outside, and rolled using hot and cold rolling methods, to meet the final specifications of the target.

[0008] For HEU targets, a cylindrical geometry was chosen while LEU targets have a plate shape.

[0009] Separating isotopes from UALx targets produces significant amounts of high and low level wastes with left-over uranium, which are not environmentally friendly, are labor intensive, and are costly. Although LEU targets comply with nuclear non-proliferation treaties, the supply of uranium remains sensitive with constraints in terms of traceability.

[0010] Consequently, there is room for improved production methods and corresponding targets for I-131 production to cope with the increased demand of this isotope, and in support of nuclear nonproliferation.

Summary of the invention

[0011] It is an object of embodiments of the present invention to provide good methods and components for the production of lodine-131 isotopes.

[0012] The above objective is accomplished by a method and components in accordance with the present invention.

[0013] The present invention relates to a target for the production of lodine-131 isotopes, the target comprising aluminum telluride particles within an aluminum matrix, the aluminum matrix being covered with an aluminum-based cladding layer.

[0014] It is an advantage of embodiments of the present invention that improved methods and systems for the production of lodine-131 which can be used for medical imaging and/or for medical therapy are established.

[0015] It is an advantage of embodiments of the present invention that the risk of target failure based on excessive heating can be limited or even avoided.

[0016] Where reference is made to an aluminum matrix, reference is made to an aluminum matrix or an aluminum matrix doped with tellurium.

[0017] The aluminum-based cladding may for example be a cladding made of Al-6061 alloy, embodiments not being limited thereto.

[0018] It is an advantage of embodiments of the present invention that the consequences of target failure can be limited. It is an advantage of embodiments of the present invention that these may allow for use of neutron capture reactions instead of fission reactions in the production of Iodine-131 isotopes. It is an advantage of embodiments of the present invention that production methods and systems are provided for Iodine-131 isotope production which are more environmentally friendly.

[0019] It is an advantage of embodiments of the present invention that production methods and systems are provided for Iodine-131 isotope production which are less labor intensive.

[0020] It is an advantage of embodiments of the present invention that production methods and systems are provided for Iodine-131 isotope production based on materials that are less sensitive with constraints in terms of traceability and that comply or more easily comply with nuclear non-proliferation treaties.

[0021] In some embodiments, the aluminum matrix with the aluminum telluride particles may be formed as one or more plate shapes, the one or more plate shapes forming one or more sandwiched plates with aluminum cladding layers sandwiching each of the plate shapes. Such plates may be planar. In alternative arrangements, the plates may be non-planar, such as for example tubular in shape. In other embodiments, the aluminum matrix with aluminum telluride particles may have another shape while being embedded by aluminum cladding. In one embodiment, the system may for example be a cylinder with an embedding aluminum coating as cladding.

[0022] It is an advantage of embodiments of the present invention that a large irradiation surface is obtained, thus allowing efficient cooling.

[0023] The target may be formed as a stack of sandwiched plates.

[0024] The aluminum cladding layers may be fully embedding the matrix material. It is an advantage of embodiments of the present invention that a full embedding of the aluminum telluride particles by an aluminum cladding is obtained, thus preventing the I-131 generated in these particles via neutron capture reactions from direct interaction with the environment.

[0025] The aluminum cladding layer may have an average thickness between 0,1mm and 10mm.

[0026] The aluminum telluride particles may comprise at least 80% of $Al2Te3$ and/or $Al2Te5$, e.g. at least 90% of $Al2Te3$ and/or $Al2Te5$, or e.g. at least 95% of $Al2Te3$ and/or $Al2Te5$.

[0027] The aluminum telluride may be at least 80% of $Al2Te3$, e.g. at least 90% of $Al2Te3$, or e.g. at least 95% of $Al2Te3$.

[0028] Whereas other tellurides may be present, the predominant use of $Al2Te3$ or $Al2Te3$ alone may be advantageous since it has a higher melting point than the other tellurides.

[0029] It is an advantage of embodiments of the present invention that by using $Al2Te3$, the system is thermally more stable than conventional targets in which capsules with Te or $TeO2$ powder is used. It is an advantage of embodiments of the present invention that the aluminides have a relative high melting temperature being significantly higher than metallic Tellurium or $TeO2$, and even higher than the melting temperature of the covering aluminum layer.

[0030] The volume fraction of aluminum telluride in the target may be larger than 10%, e.g. in the range of 10% to 60%, e.g. in the range 20% to 60%, e.g. in the range 30% to 60%, e.g. in the range 40% to 60%. The volume fraction of aluminum telluride may be limited at the upper side in view of the sticking properties of the target material, i.e. to guarantee that the target material behaves as a single material and does not fall apart.

[0031] It is an advantage of embodiments of the present invention that by using $Al2Te3$, or somewhat less advantageous by using $Al2Te5$, a higher Tellurium density in the target can be obtained than when using other intermetallic aluminum tellurides.

[0032] The present invention also relates to the use of a target as described above for the production of Iodine-131 isotopes.

[0033] Particular and preferred aspects of the invention are set out in the accompanying independent and dependent claims. Features from the dependent claims may be combined with features of the independent claims and with features of other dependent claims as appropriate and not merely as explicitly set out in the claims.

[0034] For purposes of summarizing the invention and the advantages achieved over the prior art, certain objects and advantages of the invention have been described herein above. Of course, it is to be understood that not necessarily all such objects or advantages may be achieved in accordance with any particular embodiment of the invention. Thus, for example, those skilled in the art will recognize that the invention may be embodied or carried out in a manner that achieves or optimizes one advantage or group of advantages as taught herein without necessarily achieving other objects or advantages as may be taught or suggested herein.

[0035] The above and other aspects of the invention will be apparent from and elucidated with reference to the embodiment(s) described hereinafter.

Brief description of the drawings

[0036] The invention will now be described further, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 illustrates a Tellurium-Aluminum binary phase diagram, illustrating properties of materials used in embodiments of the present invention.
FIG. 2 illustrates an example of a target design according to an embodiment of the present invention.
FIG. 3 illustrates the specific activity of I-131 obtained as function of the irradiation length under neutron flux conditions of the Belgian Reactor 2, for an Al2Te3-type target according to an example of an embodiment of the present invention.

[0037] The drawings are only schematic and are non-limiting. In the drawings, the size of some of the elements may be exaggerated and not drawn on scale for illustrative purposes. The dimensions and the relative dimensions do not necessarily correspond to actual reductions to practice of the invention.

[0038] Any reference signs in the claims shall not be construed as limiting the scope.

Detailed description of illustrative embodiments

[0039] The present invention will be described with respect to particular embodiments and with reference to certain drawings but the invention is not limited thereto but only by the claims.

[0040] The terms first, second and the like in the description and in the claims, are used for distinguishing between similar elements and not necessarily for describing a sequence, either temporally, spatially, in ranking or in any other manner. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other sequences than described or illustrated herein.

[0041] Moreover, directional terminology such as top, bottom, front, back, leading, trailing, under, over and the like in the description and the claims is used for descriptive purposes with reference to the orientation of the drawings being described, and not necessarily for describing relative positions. Because components of embodiments of the present invention can be positioned in a number of different orientations, the directional terminology is used for purposes of illustration only, and is in no way intended to be limiting, unless otherwise indicated. It is, hence, to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other orientations than described or illustrated herein.

[0042] It is to be noticed that the term "comprising", used in the claims, should not be interpreted as being restricted to the means listed thereafter; it does not exclude other elements or steps. It is thus to be interpreted as specifying the presence of the stated features, integers, steps or components as referred to, but does not preclude the presence or addition of one or more other features, integers, steps or components, or groups thereof. Thus, the scope of the expression "a device comprising means A and B" should not be limited to devices consisting only of components A and B. It means that with respect to the present invention, the only relevant components of the device are A and B.

[0043] Reference throughout this specification to "one embodiment" or "an embodiment" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment, but may. Furthermore, the particular features, structures or characteristics may be combined in any suitable manner, as would be apparent to one of ordinary skill in the art from this disclosure, in one or more embodiments.

[0044] Similarly, it should be appreciated that in the description of exemplary embodiments of the invention, various features of the invention are sometimes grouped together in a single embodiment, figure, or description thereof for the purpose of streamlining the disclosure and aiding in the understanding of one or more of the various inventive aspects. This method of disclosure, however, is not to be interpreted as reflecting an intention that the claimed invention requires more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive aspects lie in less than all features of a single foregoing disclosed embodiment. Thus, the claims following the detailed description are hereby expressly incorporated into this detailed description, with each claim standing on its own as a separate embodiment of this invention.

[0045] Furthermore, while some embodiments described herein include some but not other features included in other embodiments, combinations of features of different embodiments are meant to be within the scope of the invention, and form different embodiments, as would be understood by those in the art. For example, in the following claims, any of the claimed embodiments can be used in any combination.

[0046] It should be noted that the use of particular terminology when describing certain features or aspects of the invention should not be taken to imply that the terminology is being re-defined herein to be restricted to include any specific characteristics of the features or aspects of the invention with which that terminology is associated.

[0047] In the description provided herein, numerous specific details are set forth. However, it is understood that embodiments of the invention may be practiced without these specific details. In other instances, well-known methods, structures and techniques have not been shown in detail in order not to obscure an understanding of this description.

[0048] In a first aspect, the present invention relates to a target for the production of Iodine-131 isotopes. The target according to embodiments of the present invention comprises aluminum telluride particles within an aluminum matrix. According to embodiments of the present invention, the aluminum telluride particles that can be used can be any type of intermetallic compounds, such as for example AlTe, α-Al2Te3, β-Al2Te3, and Al2Te5, or a combination thereof. Advantageously, intermetallic compounds with a relatively high tellurium density are used. In some embodiments, the intermetallic compound used is predominantly Al2Te3. It is an advantage that Al2Te3 is thermally stable with a melting temperature of 865.4°C, almost double that of Al2Te5 and above pure tellurium or aluminum. By way of illustration, embodiments of the present invention not being limited thereby, the binary phase diagram for aluminum telluride intermetallic compounds is given in FIG. 1. The aluminum telluride particles may in some embodiments comprise at least 80% of Al2Te3 and/or Al2Te5, e.g. at least 90% of Al2Te3 and/or Al2Te5, or e.g. at least 95% of Al2Te3 and/or Al2T5. In other embodiments, the aluminum telluride may be at least 80% of Al2Te3, e.g. at least 90% of Al2Te3, or e.g. at least 95% of Al2Te3. With respect to the amount of aluminum telluride being present, in some embodiments, the volume fraction of aluminum telluride in the target may be in the range of 10% to 60%.

[0049] According to embodiments, the aluminum matrix furthermore is covered with an aluminum-based cladding layer. Where reference is made to aluminum-based cladding layer, reference is made to a cladding material comprising aluminum or aluminum alloy, advantageously comprising at least 50 volume % aluminum or aluminum alloy, e.g. comprising at least 75% or at least 90% or at least 95% aluminum or aluminum alloy. The aluminum-based cladding layer may for example comprise or be Al-6061 alloy. The cladding layer may be fully embedding the aluminum matrix. The cladding layer may have an average thickness between 0.1mm and 10mm, although embodiments are not limited thereto.

[0050] In some advantageous embodiments, the matrix with aluminum telluride particles Is formed as one or more plate shapes, the one or more plate shapes forming one or more sandwiched plates with aluminum cladding layers sandwiching the or each of the plates. By way of illustration, an exemplary configuration is shown in FIG. 2 whereby the matrix with aluminum telluride particles is a single plate embedded in a cladding layer. Furthermore, FIG. 3 illustrates a configuration wherein the final target is a stack of sandwiched plates, as also used in the simulations in the example given below. It is to be noted that, whereas in the present example rectangular shaped plates are used, embodiments of the present invention are not limited thereto and also other shapes could be used.

[0051] In another aspect, the present invention also relates to the use of a target as described above for the production of Iodine-131 isotopes.I-131 isotopes may for example be used for diagnostic purposes, such as for example in dysfunctions of the thyroid gland. The thyroid absorbs iodine to produce hormones and I-131 isotopes can be used to visualize the thyroid using gamma cameras. The latter helps in diagnosing various thyroid conditions, including hyperthyroidism and thyroid cancer. In some embodiments, I-131 isotopes may also be used for therapeutic purposes, for example in the treatment of thyroid disorders, like for example thyroid cancer or hyperthyroidism. The beta radiation emitted by I-131 is effective in destroying thyroid tissue. This is utilized in the treatment of overactive thyroid (hyperthyroidism) and to ablate (destroy) residual thyroid tissue after thyroid cancer surgery. The treatment is often referred to as radioiodine therapy.

[0052] By way of illustration, embodiments of the present invention not being limited thereto, an example of targets based on aluminum telluride is discussed below.

Example

[0053] In the example, the target is a sandwiched plate, where the meat is a dispersion of aluminum telluride particles in an aluminum matrix. The meat is cladded with aluminum 6061. Examples of dimensions of a target that could be used are indicated below in table 1, although embodiments are not limited thereto and other dimensions also may be used.

Table 1: Target dimensions

Dimensions		
Plate	Width	40 ±3mm
	Length	220 ±7mm
	Thickness	2mm

(continued)

Dimensions		
Meat	Width	32 ±3mm
	Length	206 ±7mm
	Thickness	1.2mm
	Porosity	20
Edge	Width	3mm
	Length	4mm
Cladding	Thicknes	0.4 mm
	Density	2.8 g/cc

[0054] In the present example, use is made of Al2Te3 having a melting temperature of 865.4°C, which is almost double that of Al2Te5 and above pure aluminum. In the present example, two volume loadings are tested. The first volume loading tested was a 35vol% loading of Al2Te3. The second volume loading tested was a 55vol% loading of Al2Te3. Additionally, natural and enriched (100% Te130) target will be considered. Altogether, four different target compositions are considered, as indicated in Table 2 below. The composition is indicated in Table 3.

Table 2 : Different targets tested in the example

Al_2Te_3- Al target cases	**Volume fraction of meat (%)**	**Porosity (%)**	**Te total mass (g) of core**	**Al mass (g) in core**	**Al mass (g) in cladding**
Case 1: Natural Te (34% - Te-130)	35	12	10.9	12.9	26.2
Case 2: Enriched Te (100% - Te130)	35	12	10.9	12.9	26.2
Case 3: Natural Te (34% - Te-130)	55	12	17.2	9.5	26.2
Case 4: Enriched Te (100% - Te130)	55	12	17.2	9.5	26.2

Table 3 : Mass compositions for the target cases of table 2.

Isotope	**Aleph - ZAID**	**Case 1 Mass (g)**	**Case 2 mass (g)**	**Case 3 mass (g)**	**Case 4 mass (g)**
13-Al-27	130270	12,90	12,90	9,50	9,50
52-Te-120	521200	0,01	-	0,015	-
52-Te-122	521220	0,27	-	0,42	-
52-Te-123	521230	0,093	-	0,15	-
52-Te-124	521240	0,502	-	0,79	-
52-Te-125	521250	0,754	-	1,20	-
52-Te-126	521260	2,026	-	3,20	-
52-Te-128	521280	3,47	-	5,47	-
52-Te-130	521300	3,78	10,90	5,97	17,20
	Total	**23,80**	**23,80**	**26,70**	**26,70**
	Core mass (Al)	**12,90**	**12,90**	**17,20**	**17,20**
	Core mass (Te)	**10,90**	**10,90**	**9,50**	**9,50**

(continued)

Isotope	Aleph - ZAID	Case 1 Mass (g)	Case 2 mass (g)	Case 3 mass (g)	Case 4 mass (g)
	Cladding mass (Al)	26.16	26.16	26.16	26.16

[0055] In the example, calculations are performed for the BR2 reactor present at SCK-CEN. The reactor power was 52 MW. Calculations were carried out for four different cases with different composition of the Al2Te3 target as presented in table 3. Case 2 and 4 are made up of enriched Te-130 while the case 1 and 3 are made of natural tellurium in an aluminum matrix. Simulations were carried using ALEPH 2.9.0 and MCNP6 codes in conjunction with the ENDF/B library. ALEPH was used for the burnup calculation or irradiation of the samples for 0, 3, 5, 7, 14 and 16 days while MCNP was used basically to estimate the gamma heating of the targets. Since the target was irradiated in a channel which is surrounded with fuel elements, an amount of source neutrons of 25000 was used for 500 cycles. This resulted in a statistical uncertainty of 0.00021 on the k_{eff}. To ensure proper convergence of the Shannon entropy at the start of each simulation, 30 initial cycles were skipped. Calculations were repeated if the MCNP code recommended more cycles should be skipped.

[0056] The simulations involve (1) calculating I-131 production yields in targets according to the present invention (composed of Al2Te3 dispersed in an aluminum matrix) after neutron irradiation in BR2 and (2), calculating the anti-reactivity or rather, the reactivity effect of using a beryllium plug or light water instead of the Al2Te3 target within the BR2 reactor.

[0057] The reactivity effect can be expressed as:

$$\Delta\rho = \left(k_2 - k_1\right) / \left(k_2 \times k_1\right) \cdot \beta_{\mathrm{eff}}$$

where k_1 and k_2 are the respective effective multiplication factors obtained as results of MCNP calculations of two different core configurations. To measure the reactivity effect, MCNP calculations were performed by replacing the entire PRF in the channel with a berylium plug and also with light water. Note that Δ_ρ is calculated by utilizing a delayed neutron fraction, β_{eff} = 0.0072.

[0058] The target was modelled with cladding made of Al and a target core of volume, 7.9104 cm3 with the following dimensions: Length = 20.60 cm, Width = 0.12 cm and Thickness = 0.12 cm. Simulation indicated that a specific activity of I-131 could be obtained as shown in FIG. 3. The results are expressed per gram Te (metal), whereby in this example each target comprised 11g of Te. From the results, it can be seen that approximately 16 Curie/target could be obtained by irradiating 7 days.

[0059] While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive. The foregoing description details certain embodiments of the invention. It will be appreciated, however, that no matter how detailed the foregoing appears in text, the invention may be practiced in many ways. The invention is not limited to the disclosed embodiments.

Claims

1. A target for the production of Iodine-131 isotopes, the target comprising aluminum telluride particles within an aluminum matrix, the aluminum matrix being covered with an aluminum-based cladding layer.

2. The target according to the previous claim, wherein the aluminum matrix with the aluminum telluride particles is formed as one or more plate shapes, the one or more plate shapes forming one or more sandwiched plates with aluminum cladding layers sandwiching each of the plate shapes.

3. The target according to claim 2, wherein the target is formed as a stack of sandwiched plates.

4. The target according to claim 2 or 3, wherein the plates are planar.

5. The target according to claim 2 or 3, wherein the plates are tubular shaped.

6. The target according to any of the previous claims, wherein the aluminum cladding layers are fully embedding the matrix material.

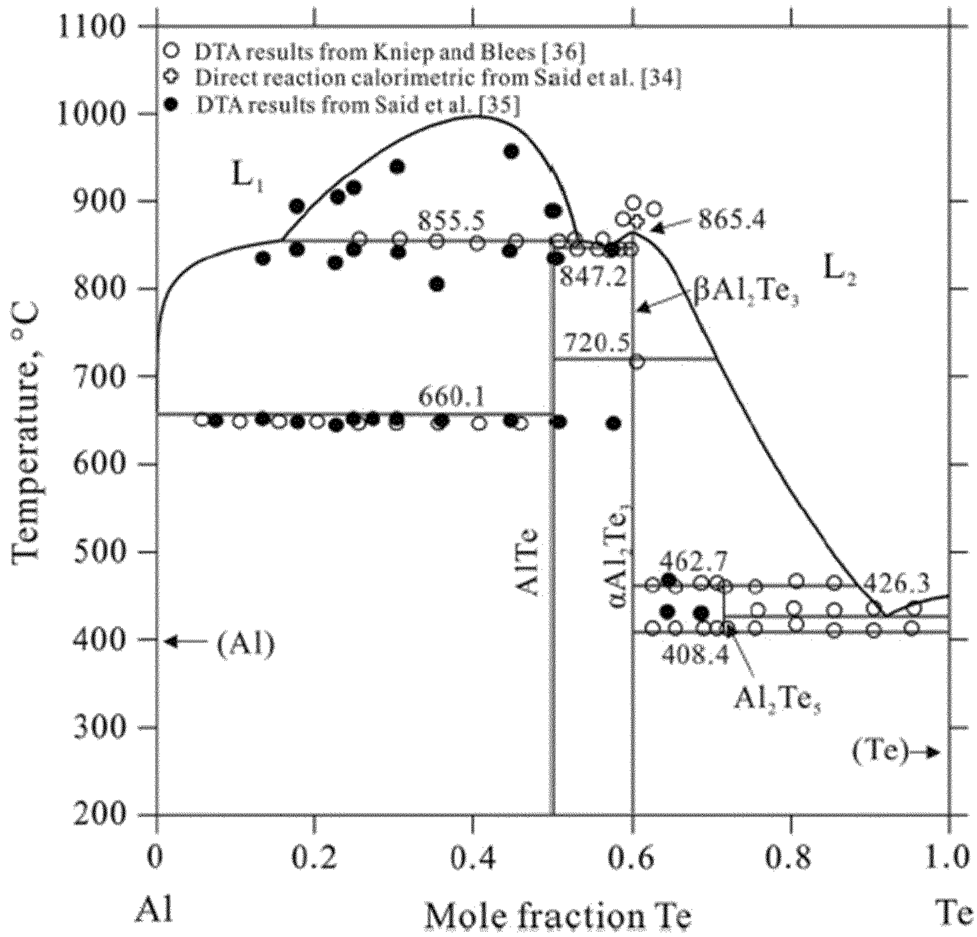
7. The target according to any of the previous claims, wherein the aluminum cladding layer has an average thickness between 0,1mm and 10mm.

8. The target according to any of the previous claims, wherein the aluminum telluride particles comprise at least 80% of Al2Te3 and/or Al2Te5, e.g. at least 90% of Al2Te3 and/or Al2Te5, or e.g. at least 95% of Al2Te3 and/or Al2Te5.

9. The target according to any of the previous claims, wherein the aluminum telluride is at least 80% of Al2Te3, e.g. at least 90% of Al2Te3, or e.g. at least 95% of Al2Te3.

10. The target according to any of the previous claims, wherein the volume fraction of aluminum telluride in the target is in the range of 10% to 60%.

11. Use of a target according to any of claims 1 to 10 for the production of Iodine-131 isotopes.



DTA results from Kniep and Blees [36]
Direct reaction calorimetric from Said et al. [34]
DTA results from Said et al. [35]
1100
1000
900
800
700
600
500
400
300
200
Temperature, °C
L1
L2
855.5
865.4
847.2
βAl2Te3
720.5
660.1
AlTe
αAl2Te3
462.7
426.3
408.4
Al2Te5
(Al)
(Te)
0
0.2
0.4
0.6
0.8
1.0
Al
Mole fraction Te
Te

FIG. 1

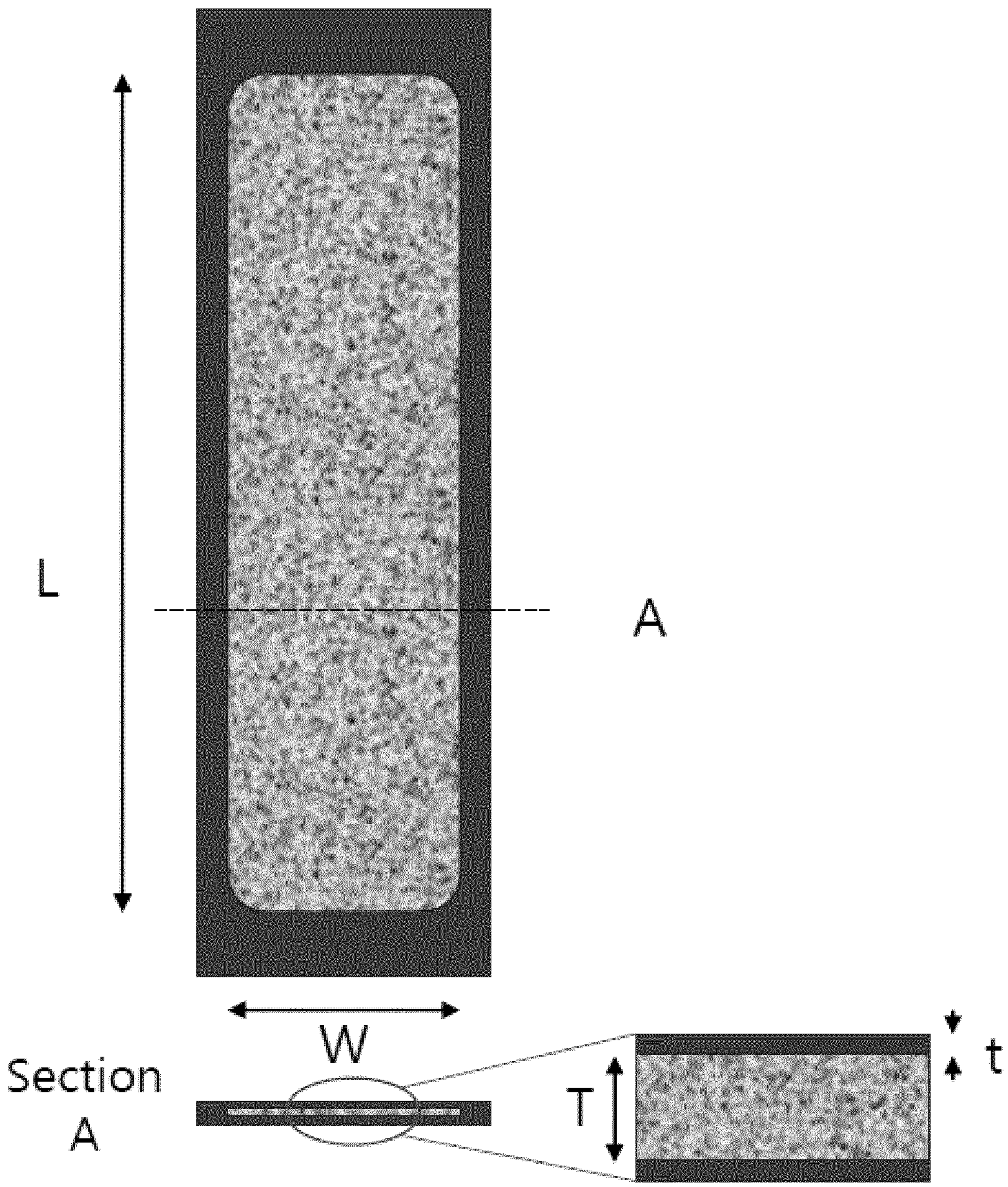
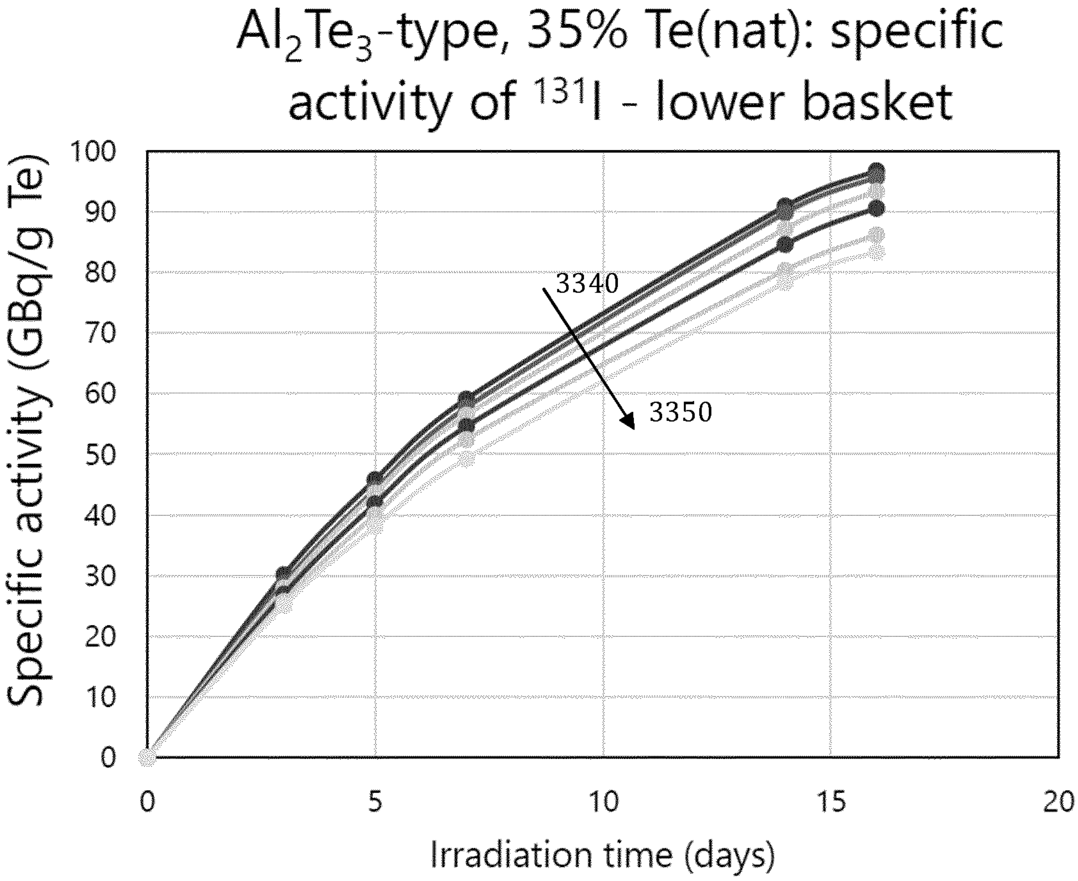


FIG. 2



Al_2Te_3-type, 35% Te(nat): specific activity of ^{131}I - lower basket
Specific activity (GBq/g Te)
100
90
80
70
60
50
40
30
20
10
0
3340
3350
0
5
10
15
20
Irradiation time (days)

FIG. 3

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 23 21 8937

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 7 804 928 B2 (WISCONSIN ALUMNI RES FOUND [US]) 28 September 2010 (2010-09-28) * column 5, line 35 - column 6, line 41; claims; figures *	1-11	INV. G21G1/10 H05H6/00 ADD. G21G1/00
A	NYE ET AL: "A new binary compound for the production of ^1^2^4I via the ^1^2^4Te(p,n)^1^2^4I reaction", APPLIED RADIATION AND ISOTOPES, ELSEVIER, OXFORD, GB, vol. 65, no. 4, 1 February 2007 (2007-02-01), pages 407-412, XP005868750, ISSN: 0969-8043, DOI: 10.1016/J.APRADISO.2006.10.012 * abstract *	1-11	

TECHNICAL FIELDS SEARCHED (IPC)

H05H
G21G

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	6 May 2024	Smith, Christopher

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 21 8937

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

06-05-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 7804928 B2	28-09-2010	US 2007064858 A1	22-03-2007
		US 2009213978 A1	27-08-2009

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Non-patent literature cited in the description

- Manual for reactor produced radioisotopes. International Atomic Energy Agency, 2003 **[0003]**