urenco
Stable Isotopes

Urenco Stable Isotopes

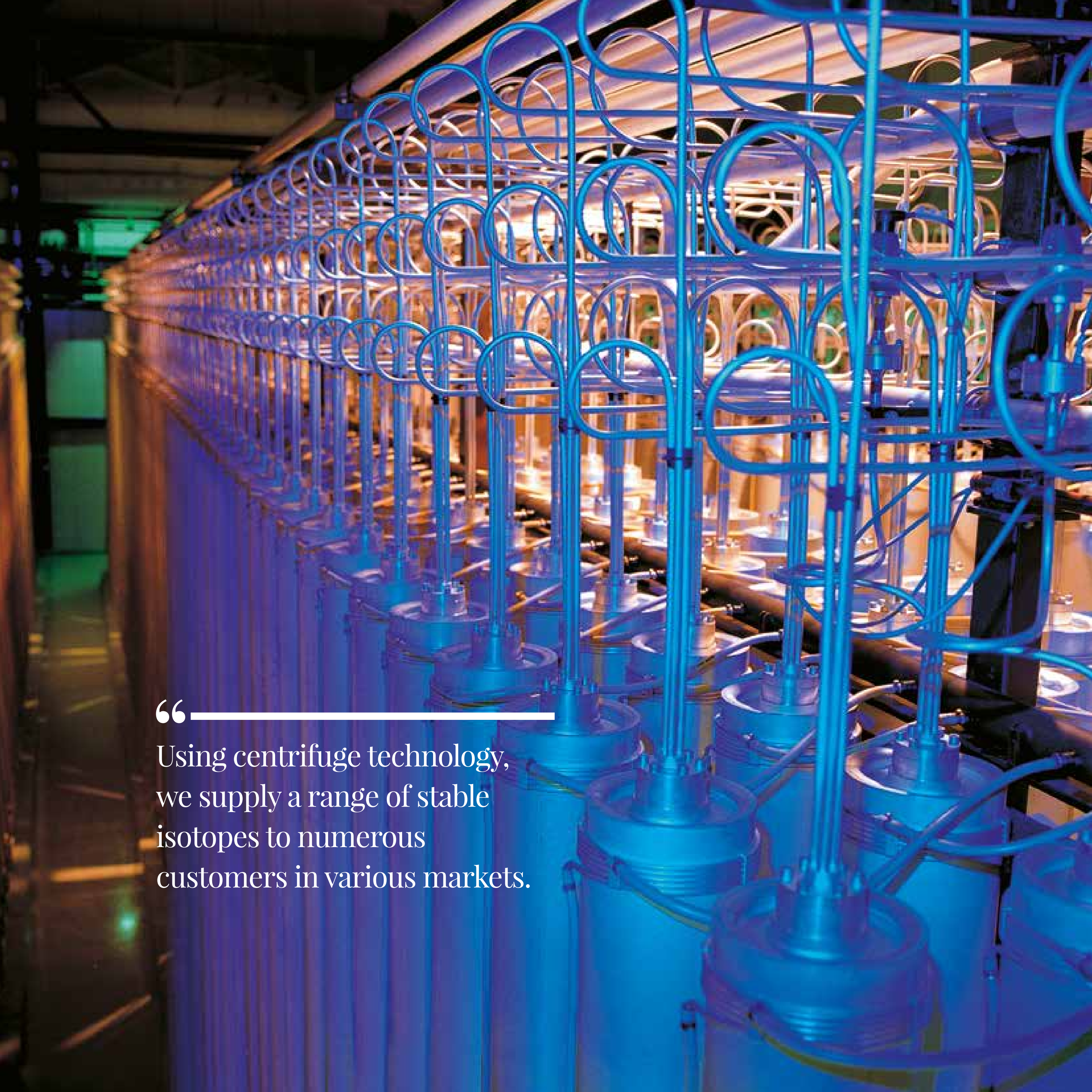

Argon

Urenco Stable Isotopes, based at Urenco's facility in Almelo, the Netherlands, employs centrifuge technology to separate isotopes of various elements for medical, industrial and research applications.

The centrifuge technology used and owned by Urenco, an international supplier of enrichment services and fuel cycle products, is the result of nearly 50 years of continuous development.

Due to its versatility, application of the gas centrifuge is not limited to the separation of uranium isotopes alone, it is also utilised for the separation of other isotopes, including: cadmium, germanium, iridium, molybdenum, selenium, tellurium, titanium, tungsten, xenon and zinc.

> "Urenco Stable Isotopes draws on Urenco's expertise and capabilities in centrifuge technology to produce stable isotopes with social, environmental and commercial value.



> Using centrifuge technology, we supply a range of stable isotopes to numerous customers in various markets.

Isotopes

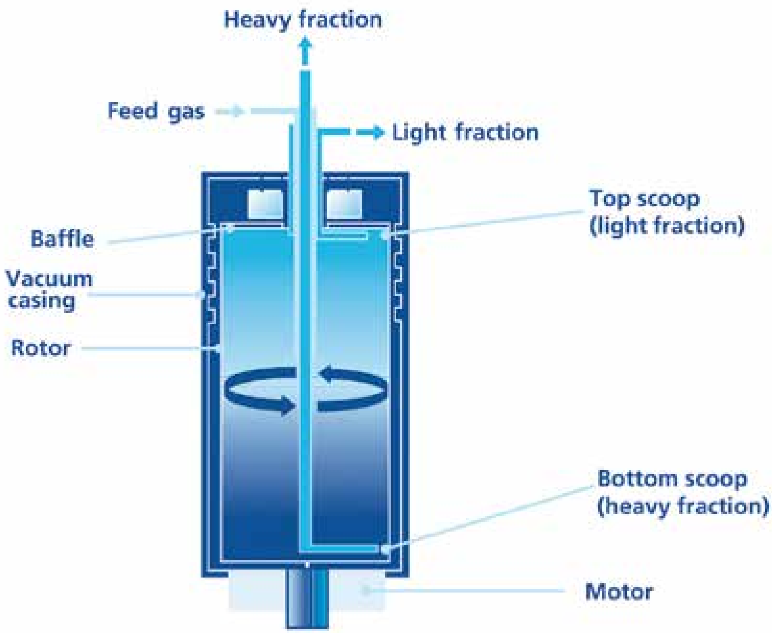
An isotope is an element that has the same number of protons (the same atomic number) but a different number of neutrons in the nucleus (different atomic mass).

Isotopes can either be stable or unstable. Due to their unique properties, stable isotopes are used in a variety of applications, including: medical diagnosis, semiconductor production for electronic devices and research on materials used in nuclear environments.

Gas centrifuges

A gas centrifuge consists of a fast spinning rotor inside a vacuum casing. Gas is fed into the rotor where it is accelerated to the rotational frequency. Gas molecules are then subjected to centrifugal forces induced by the centripetal acceleration.

The centrifugal forces push the heavier molecules closer to the wall of the rotor than the lighter molecules. The gas is then extracted from the centrifuge by a set of gas extraction scoops. The heavier fraction scoop is located near the rotor wall, whereas the lighter fraction scoop is placed towards the centre of the rotor.



Using centrifuge technology designed and deployed by Urenco, isotopes are enriched to exceed 99% or depleted below 1%.

Cadmium	(^{106}Cd, ^{108}Cd, ^{110}Cd, ^{111}Cd, ^{112}Cd, ^{113}Cd, ^{114}Cd and ^{116}Cd)
Germanium	(^{70}Ge, ^{72}Ge, ^{73}Ge, ^{74}Ge and ^{76}Ge)
Iridium	(^{191}Ir and ^{193}Ir)
Molybdenum	(^{92}Mo, ^{94}Mo, ^{95}Mo, ^{96}Mo, ^{97}Mo, ^{98}Mo and ^{100}Mo)
Selenium	(^{74}Se, ^{76}Se, ^{77}Se, ^{78}Se, ^{80}Se and ^{82}Se)
Tellurium	(^{120}Te, ^{122}Te, ^{123}Te, ^{124}Te, ^{125}Te, ^{126}Te, ^{128}Te and ^{130}Te)
Titanium	(^{46}Ti, ^{47}Ti, ^{48}Ti, ^{49}Ti and ^{50}Ti)
Tungsten	(^{180}W, ^{182}W, ^{183}W, ^{184}W and ^{186}W)
Xenon	(^{124}Xe, ^{126}Xe, ^{128}Xe, ^{129}Xe, ^{130}Xe, ^{131}Xe, ^{132}Xe, ^{134}Xe and ^{136}Xe)
Zinc	(^{64}Zn, ^{66}Zn, ^{67}Zn, ^{68}Zn and ^{70}Zn)

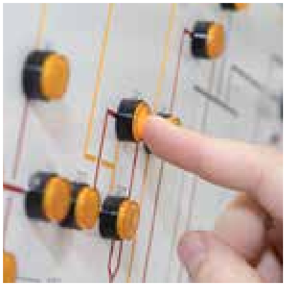
Conversion

We supply isotopes in many different chemical forms such as oxide, metal, gaseous or elemental. We are also able to convert materials into other forms in accordance with customer requests. The materials can be supplied in cylinders, discs or pellets.

Development

New applications for stable isotopes continue to be developed and Urenco Stable Isotopes is actively engaged in discussions with customers on how to support this growing demand.

One of our key goals is to ensure our customers are involved in our research and development projects from an early stage. This ensures high quality and cost efficient products and solutions.



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Through the flexible operation of our centrifuge technology, Urenco Stable Isotopes produces medical radioisotopes for three specific areas of the medical sector – diagnostics, therapy and pain relief.

Diagnostics

Nuclear diagnostic imaging techniques enable medical professionals around the world to identify diseases at an early stage, track disease progression, allow for accurate disease staging and provide predictive information about the likely success of alternative therapy options.

One of the most important diagnostic techniques is gamma imaging. Nuclear medicine departments use gamma cameras to detect diseases in various organs, including: heart, brain, bone, lung and the thyroid. Urenco Stable Isotopes produces the stable precursors for the radioisotopes ^{67}gallium (i.e. ^{68}zinc), ^{111}indium (i.e. ^{112}cadmium) and ^{123}iodine (i.e. ^{124}xenon), which are all used in these cameras.

Another diagnostic radioisotope is ^{124}iodine, which is used for positron emission tomography. We produce the stable precursor ^{124}tellurium.

Urenco Stable Isotopes also produces enriched ^{98}molybdenum and ^{100}molybdenum, which after irradiation is activated to ^{99}molybdenum. ^{99}Molybdenum decays into ^{98m}technetium which is used as a tracer and detected in the body by medical diagnostic imaging techniques.

Molybdenum (Mo)

Naturally occurring molybdenum has seven stable isotopes in the following abundance:

^{92}Mo 14.5%

^{94}Mo 9.2%

^{95}Mo 15.8%

^{96}Mo 16.7%

^{97}Mo 9.6%

^{98}Mo 24.4%

^{100}Mo 9.8%

> Each year, more than one million patient treatments are performed using medical radioisotopes.

Zinc (Zn)

Naturally occurring zinc has five stable isotopes in the following abundance:

^{64}Zn 48.6%

^{66}Zn 27.9%

^{67}Zn 4.1%

^{68}Zn 18.8%

^{70}Zn 0.6%

Cadmium (Cd)

Naturally occurring cadmium has eight stable isotopes in the following abundance:

^{106}Cd 1.3%

^{108}Cd 0.9%

^{110}Cd 12.5%

^{111}Cd 12.8%

^{112}Cd 24.1%

^{113}Cd 12.2%

^{114}Cd 28.7%

^{116}Cd 7.5%

Xenon (Xe)

Naturally occurring xenon has nine stable isotopes in the following abundance:

^{124}Xe 0.1%

^{126}Xe 0.1%

^{128}Xe 1.9%

^{129}Xe 26.4%

^{130}Xe 4.1%

^{131}Xe 21.2%

^{132}Xe 26.9%

^{134}Xe 10.4%

^{136}Xe 8.9%

Tellurium (Te)

Naturally occurring tellurium has eight stable isotopes in the following abundance:

^{120}Te 0.1%

^{122}Te 2.6%

^{123}Te 0.9%

^{124}Te 4.7%

^{125}Te 7.1%

^{126}Te 18.8%

^{128}Te 31.7%

^{130}Te 34.1%

Therapy

Medical radioisotopes are also used for therapeutic purposes. Brachytherapy is a procedure which uses temporary irradiation close to the area of disease, in particular for cancer and stenosis. Urenco Stable Isotopes produces ^{191}iridium for ^{192}iridium sources used in remotely controlled afterloaders, which deliver the radiation dose to the patient.

Another example of brachytherapy is the use of radioactive sources (seeds) in tumours, in particular prostate cancer. A significant percentage of patients diagnosed with this disease are treated with these radioactive seeds. The radioactive source often used in the seeds is ^{125}iodine (i.e. ^{124}xenon).

Other examples of therapeutic radioisotopes are ^{67}copper (i.e. ^{68}zinc) and ^{77}bromine (i.e. ^{77}selenium).

Pain relief

Palliative care of pain arising from secondary metastasis derived from the spread of breast, prostate and lung cancers is under development. A number of radioisotopes are already being used on a regular basis, while the potential of other isotopes is being investigated. One such isotope is ^{188}rhenium, which is produced from ^{186}tungsten.

Iridium (Ir)

Naturally occurring iridium has two stable isotopes in the following abundance:

^{191}Ir 37.3%

^{193}Ir 62.7%

Xenon (Xe)

Naturally occurring xenon has nine stable isotopes in the following abundance:

^{124}Xe 0.1%

^{126}Xe 0.1%

^{128}Xe 1.9 %

^{129}Xe 26.4%

^{130}Xe 4.1%

^{131}Xe 21.2%

^{132}Xe 26.9%

^{134}Xe 10.4%

^{136}Xe 8.9%

Selenium (Se)

Natural occurring selenium has six stable isotopes in the following abundance:

^{74}Se 0.9%

^{76}Se 9.4%

^{77}Se 7.6%

^{78}Se 23.8%

^{80}Se 49.6%

^{82}Se 8.7%

Titanium (Ti)

Natural occurring titanium has five stable isotopes in the following abundance:

^{46}Ti 8.3%

^{47}Ti 7.4%

^{48}Ti 73.7%

^{49}Ti 5.4%

^{50}Ti 5.2%

Tungsten

Naturally occurring tungsten has five stable isotopes in the following abundance:

^{180}W 0.1%

^{182}W 26.5%

^{183}W 14.3%

^{184}W 30.7%

^{186}W 28.4%

> Our main industrial isotope is depleted ^{64}zinc which is used widely in the nuclear industry.

Urenco Stable Isotopes is continuously developing products for industrial use within the nuclear, non-destructive testing and semiconductor industry.

Nuclear industry

Our main industrial isotope is depleted ^{64}zinc which is used widely in the nuclear industry. The addition of zinc to nuclear reactors greatly reduces corrosion processes, including stress corrosion cracking.

Zinc also reduces the amount of radioactive ^{60}cobalt formed as a result of the activation of natural cobalt in the construction materials of the reactor. ^{60}Cobalt is a major contributor to radiation build up in cooling systems and can cause elevated dose rates of maintenance personnel. If natural zinc is injected, ^{64}zinc forms the radioactive ^{65}zinc which negates the beneficial reduction of ^{60}cobalt. If the ^{64}zinc isotope is removed prior to injection in the cooling system, full advantage can be taken from the ^{60}cobalt level reduction and the average dose rates are substantially reduced.

We often provide large quantities of depleted ^{64}zinc in the form of depleted zinc oxide pellets or powder for boiling water reactors and depleted zinc acetate for pressurised water reactors.

Zinc (Zn)

Naturally occurring zinc has five stable isotopes in the following abundance:

^{64}Zn 48.6%

^{66}Zn 27.9%

^{67}Zn 4.1%

^{68}Zn 18.8%

^{70}Zn 0.6%

Non-destructive testing

Non-destructive testing is often performed with gamma cameras. Several gamma sources are in use with ^{192}iridium sources being the most common ones. ^{75}Selenium sources have a slightly softer gamma spectrum and these are typically used for thin walled products.

^{192}Iridium is mostly produced from natural iridium but for high specific activity, enriched ^{91}iridium is used as a precursor. The radioisotope ^{75}selenium is produced from enriched ^{74}selenium. ^{191}Iridium and ^{74}selenium are both produced by us.

> “^{192}Iridium produced from Urenco’s ^{191}iridium is used for non-destructive testing of constructions.

Iridium (Ir)

Naturally occurring iridium has two stable isotopes in the following abundance:

^{191}Ir 37.3%

^{193}Ir 62.7%

Selenium (Se)

Natural occurring selenium has six stable isotopes in the following abundance:

^{74}Se 0.9%

^{76}Se 9.4%

^{77}Se 7.6%

^{78}Se 23.8%

^{80}Se 49.6%

^{82}Se 8.7%

Semiconductor production

Within the semiconductor industry, a key priority is research and development. Urenco Stable Isotopes is able to and constantly looking for opportunities to contribute to these developments.

Germanium tetrafluoride is used in the semiconductor industry for the pre-amorphisation implant process. The use of germanium tetrafluoride, enriched in the isotope ^{72}germanium, improves this process and increases the beam current. We supply germanium tetrafluoride enriched in ^{72}germanium, tailored to the customer's specific requirements.

Silicon is also widely used in the semiconductor industry. ^{28}Silicon is currently used in various research and development projects, including the race to build quantum computers, machines that should offer immense processing power by exploiting the oddities of quantum mechanics.

Germanium (Ge)

Naturally occurring germanium has five stable isotopes in the following abundance:

^{70}Ge 20.6%

^{72}Ge 27.4%

^{73}Ge 7.8%

^{74}Ge 36.5%

^{76}Ge 7.7%

Silicon (Si)

Naturally occurring silicon has three stable isotopes in the following abundance:

^{28}Si 92.2%

^{29}Si 4.7%

^{30}Si 3.1%

Urenco's stable isotopes are used for several research applications, including: food absorption studies, material research and nuclear physics.

Food absorption studies

A significant amount of research is invested into the diet of children living in poor and underdeveloped communities. The diet of these children often does not contain the right amounts of essential elements such as zinc, iron, calcium and magnesium. Studies are performed to verify if and how these essential elements are absorbed by the body and where those go, once inside the body. Our zinc isotopes are regularly used in these food absorption studies.

Zinc (Zn)

Naturally occurring zinc has five stable isotopes in the following abundance:

^{64}Zn 48.6%

^{66}Zn 27.9%

^{67}Zn 4.1%

^{68}Zn 18.8%

^{70}Zn 0.6%

“

Titanium depleted in the isotope ^{46}titanium is used as an encapsulation material for radioactive sources.

Material research

Materials used in nuclear environments are subjected to harsh conditions with intense neutron fluxes, for example in nuclear power reactors.

The materials are often activated by these neutron fluxes leading to a decrease in lifetime. By changing the isotopic composition of the materials, the cross section for neutron capture can be reduced significantly. This leads to lower activation, reduction in radioactive waste and increased lifetime of the materials.

Urenco Stable Isotopes produces low activating tungsten, ideally suited for use in environments with high neutron fluxes such as fission and fusion reactors.

We have also developed low activating titanium, depleted in ^{46}titanium which strongly reduces the formation of radioactive ^{46}scandium.

Titanium (Ti)

Natural occurring titanium has five stable isotopes in the following abundance:

^{46}Ti 8.3%

^{47}Ti 7.4%

^{48}Ti 73.7%

^{49}Ti 5.4%

^{50}Ti 5.2%

Tungsten (W)

Naturally occurring tungsten has five stable isotopes in the following abundance:

^{180}W 0.1%

^{182}W 26.5%

^{183}W 14.3%

^{184}W 30.7%

^{186}W 28.4%

Nuclear physics

Stable isotopes are used extensively in nuclear physics research. One example is the use of stable isotopes for the creation of super heavy elements. Our enriched ^{70}zinc and ^{50}titanium have been, and still are, extensively used for this research.

Another example is the use of enriched stable isotopes for neutrino research. Enriched isotopes such as ^{82}selenium, ^{76}germanium, ^{130}tellurium and ^{136}xenon are often incorporated in detectors, which are used for investigating the characteristics of neutrinos. These enriched isotopes produced by us have been successfully used in the field of neutrino research.

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Tellurium (Te)

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Xenon (Xe)

Naturally occurring xenon has nine stable isotopes in the following abundance:

^{124}Xe 0.1%

^{126}Xe 0.1%

^{128}Xe 1.9%

^{129}Xe 26.4%

^{130}Xe 4.1%

^{131}Xe 21.2%

^{132}Xe 26.9%

^{134}Xe 10.4%

^{136}Xe 8.9%

> “ ^{130}Tellurium is used in research into double beta decay.

Urenco Stable Isotopes
Drienemansweg 1
Postbus 158
7600 AD Almelo
The Netherlands

T: +31 (0)546545151
E: isotopes@urenco.com

www.urencostableisotopes.com