PRODUCT SHEET

Nucfilm Discs

Ra-NucfilmDiscs

Main Applications

- Determination of alpha emitting Ra isotopes in water samples via alpha spectrometry
- Determination of Ra-228 via Th-228 ingrowth and alpha spectrometry

Packing

Order N°.	Form
NU-D20-RA	Box of 20 Ra-NucfilmDiscs
NU-D100-RA	Box of 100 Ra-NucfilmDiscs

Physical and chemical properties

Disc diameter : 24.5 mm
Active diameter: 24 mm,
Disc thickness : 1.6 mm
Single absorbing side, back side writeable

Option :
Disc diameter : 26.5 mm
Active diameter: 26 mm,
Disc thickness : 1.6 mm
Single absorbing side, back side writeable

Support : Polyamid66
Active component: MnO_2

Conditions of utilization

Recommended T of utilization : /
Recommended pH of utilization : 4 - 8
Storage : Dry and dark

For additional information see enclosed literature study

Methods[1]

Reference	Description	Matrix	Analytes	Support
app_note_ra_disc	Nucfilm application note: "How to use Ra-NucfilmDiscs"	water	Ra-226, Ra-224 Ra-228	Disc

[1] Discs and methods developped by Nucfilm GmbH.

PRODUCT SHEET

Nucfilm Discs

U-NucfilmDiscs

Main Applications

- Determination of U isotopes in water samples via alpha spectrometry

Packing

Order N°.	Form
NU-D20-U	Box of 20 U-NucfilmDiscs
NU-D100-U	Box of 100 U-NucfilmDiscs

Physical and chemical properties

Disc diameter : 24.5 mm
Active diameter: 24 mm
Disc thickness : 1.1 mm
Single absorbing side, back side writeable

Support : Polycarbonate
Active component: Diphonix® resin

Conditions of utilization

Recommended T of utilization : /
Recommended pH of utilization : 2 - 3
Storage : Dry and dark

For additional information see enclosed literature study

Methods[2]

Reference	Description	Matrix	Analytes	Support
app_note_u_disc	Nucfilm application note: "How to use U-NucfilmDiscs"	water	U-234/235/238	Disc

[2] Discs and methods developped by NucFilm GmbH.

LITERATURE STUDY

Nucfilm Discs

Radium adsorbing discs
(Ra- NucfilmDisc)

MnO_2 is renowned for efficiently adsorbing Ra even at high Ca concentration. Recent improvements in the fabrication of MnO_2 layers based on anterior works (1-5) now allow the fabrication of selectively adsorbing MnO_2 coated as a thin film onto the surface of a polyamide disc. These coated substrates are available as Ra - NucfilmDiscs. Due to their high selectivity for Ra the discs allow the direct determination of Ra isotopes in water samples without applying additional radiochemical separation methods. The discs are contacted with the untreated water samples (pH 4 – 8, typical volume = 100 mL) under stirring for 6h. Under these conditions the Ra extraction is typically greater 90%. The dried disc can then be measured with a solid state alpha detector. The energy resolution of the obtained sources is very good as demonstrated in Fig.1. Using a 900 mm^2 detector and a detector to sample distance of 10 mm the 4780 keV Ra-226 peak can be fitted with the sum of a gaussian and an exponential tailing of gaussian: FWHM 30 to 40 keV and tailing: 20 to 30 keV to 1/2 peak maximum. The analysis of a 100 mL sample (counting time t = 80000 s, 900 mm^2 Si-detector at 10 mm distance) typically results in a detection limit (LLD) of 5 $mBq.L^{-1}$ for ^{226}Ra.

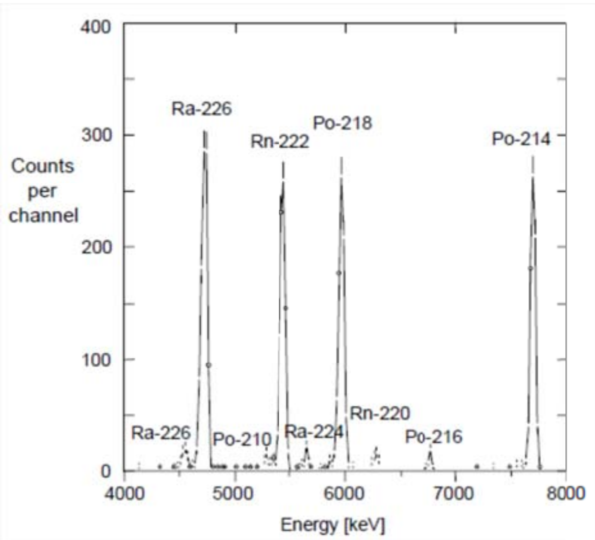

Fig. 1 : Alpha spectrum of a radium adsorbing thin film exposed to a Portuguese mineral water.

The above mentioned yield of > 90% was established for water samples having drinking water quality. With some precaution other water samples can be analyzed too, but one has to take into account that the adsorption efficiency may depend on the chemical composition of the sample. MnO_2 has a high selectivity not only for Ra but also for Ba, that when present at $mg.L^{-1}$ levels, competes with Ra for the adsorption sites, resulting in lower yields. If there are any doubts the absorption efficiency can be determined by subsequently exposing two discs to the same sample (template exposition). Each disc will adsorb the same fraction of Ra still present in solution, it is thus possible to calculate the activity of the Ra isotopes in the sample based on the count rates of each of the discs.

For low sample activities (in the order of tens of $mBq.L^{-1}$) the count rates are too low to use this method, in this case a known Ra-226 activity (some 10 mBq) can be added to the sample before exposing the second disc. It is essential to use a Ra-226 standard solution with a low Ba content (final Ba concentration in the sample to be analyzed << $mg.L^{-1}$).

In the case of sparkling waters with high mineral content Na_2EDTA is added to complex calcium. This prevents precipitation of Ca due to loss of CO_2. No noticable effect of this complexation on Ra adsorption efficiency (up to 1g/l Na_2EDTA added) is observed.

Apart from Ra, Po is also adsorbed with high efficiency. Uranium adsorption is in general low, less than 5% of the U-238 or U-234 activities present in the sample are adsorbed. There are large variations in this adsorption efficiency, these variations may be due to differences in the chemical form in which uranium is present in the sample; CO_3^{2-} forms quite stable anionic or neutral complexes with the uranyl cation (UO_2^{2+}), which are not adsorbed by the MnO_2. Carbonate thus helps avoiding U adsorption; the same is true for Th (6).

The Ra-NucFilm discs can also be used for the determination of Ra-228 by following the ingrowth of Th-228 over an extended period (7).

Uranium adsorbing discs
(U-NucfilmDisc)

U-Nucfilm discs are based on finely ground Diphonix resin® (8, 9) that has been immobilized on a polycarbonate disc in the form of a thin layer (Uranium is adsorbed very close to the surface, within about 1 µm.). The Diphonix resin® is a very strong cation exchange resin containing diphosphonate groups, which determine the resins selectivity for actinides, and sulfonate groups for increased absorption kinetics. It showed to have the required selectivity for U, while Ra adsorption is very low (8, 9). Additionally it allows working at low pH and thus eliminating potential interference of the U extraction by its complexation by dissolved CO_3^{2}.

U adsorption is considerably slower on these films than the Ra adsorption on MnO_2 films; it takes about 20h until equilibrium is reached (4h to 50% equilibrium).

After 20h a 24 mm diam. disc exposed to an acidified, stirred 100 mL sample takes up typically more than 90% of the U. The pH can be adjusted with a wide range of different acids (e.g. formic, citric or nitric acid) and should be kept below pH 3, preferably at pH 2. It is recommended to use formic acid.

After drying the exposed disc can be measured with a solid state alpha detector. As shown in Fig.2 energy resolution is not quite as good as for the MnO_2 films. Using a 900 mm^2 detector and a detector to sample distance of 10 mm the uranium peaks can be fitted with the sum of a gaussian and an exponential tailing of gaussian: FWHM 30 to 40 keV and tailing: 30 to 50 keV to 1/2 peak maximum, nevertheless the U-234 and U-238 peaks are clearly separated.

The analysis of a 100 mL sample (counting time t = 80000 s, 900 mm^2 Si-detector at 10 mm distance) typically results in a detection limit (LLD) of about 10 $mBq.L^{-1}$ for U-234 and U-238.

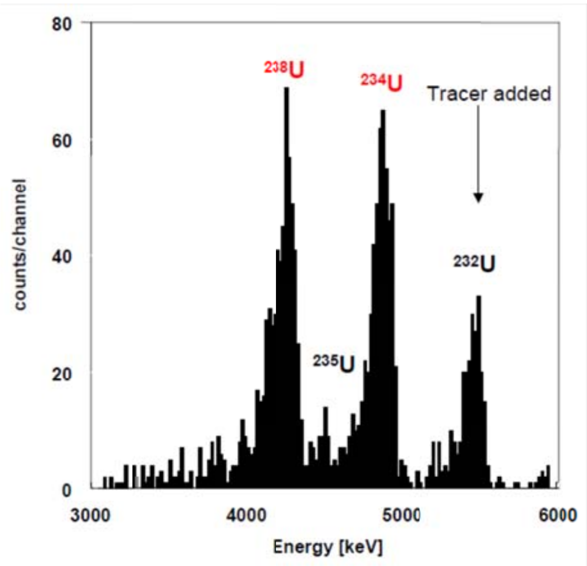

Fig 2: Alpha spectrum of a mineral water sample („Aproz Ancienne“, Valais, Switzerland) obtained using a U-Nucfilm disc; Counting conditions: 900 mm2 Si-detector at a distance of approx. 11 mm, acquisition time : 80‘000 s. Added tracer activity is 200 $mBq.L^{-1}$.

Literature

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