



14 CM



Физико-химическая таблица изостеров

Physical and Chemical Table of Izosters

15	P	16	As	33	Mo	51	Sb	69	Tm	87	Fr	88	Cm	105	(Ns)	114	Mx
17	Cl	35	Br	81	Tl	82	Pb	83	Bi	84	Po	85	At	86	Rn	115	My
18	Ar	36	Kr	84	Pb	85	Bi	86	Rn	116	Fl	117	Uu	118	Og	119	Mt
19	K	37	Rb	87	Fr	88	Cm	105	(Ns)	114	Mx	115	My	116	Fl	117	Uu
20	Ca	38	Sr	88	Ra	89	Ac	90	Th	91	Pa	92	U	93	Np	94	Pu
21	Sc	39	Y	89	La	90	Ce	91	Pr	92	Nd	93	Pm	94	Sm	95	Eu
22	Ti	40	Zr	90	Hf	91	Ta	92	W	93	Re	94	Os	95	Ir	96	Pt
23	V	41	Nb	91	Mo	92	Tc	93	Ru	94	Rh	95	Pd	96	Ag	97	Cd
24	Cr	42	Mn	92	Fe	93	Co	94	Ni	95	Cu	96	Zn	97	Ga	98	Ge
25	Mn	93	Fe	94	Co	95	Ni	96	Cu	97	Zn	98	Ga	99	Ge	100	As
26	Fe	94	Co	95	Ni	96	Cu	97	Zn	98	Ga	99	Ge	100	As	101	Se
27	Co	95	Ni	96	Cu	97	Zn	98	Ga	99	Ge	100	As	101	Se	102	Br
28	Ni	96	Cu	97	Zn	98	Ga	99	Ge	100	As	101	Se	102	Br	103	Kr
29	Cu	97	Zn	98	Ga	99	Ge	100	As	101	Se	102	Br	103	Kr	104	Rb
30	Zn	98	Ga	99	Ge	100	As	101	Se	102	Br	103	Kr	104	Rb	105	Sr
31	Ga	99	Ge	100	As	101	Se	102	Br	103	Kr	104	Rb	105	Sr	106	Y
32	Ge	100	As	101	Se	102	Br	103	Kr	104	Rb	105	Sr	106	Y	107	Zr
33	As	101	Se	102	Br	103	Kr	104	Rb	105	Sr	106	Y	107	Zr	108	Nb
34	Se	102	Br	103	Kr	104	Rb	105	Sr	106	Y	107	Zr	108	Nb	109	Mo
35	Br	103	Kr	104	Rb	105	Sr	106	Y	107	Zr	108	Nb	109	Mo	110	Tc
36	Kr	104	Rb	105	Sr	106	Y	107	Zr	108	Nb	109	Mo	110	Tc	111	Ru
37	Rb	105	Sr	106	Y	107	Zr	108	Nb	109	Mo	110	Tc	111	Ru	112	Rh
38	Sr	106	Y	107	Zr	108	Nb	109	Mo	110	Tc	111	Ru	112	Rh	113	Pd
39	Y	107	Zr	108	Nb	109	Mo	110	Tc	111	Ru	112	Rh	113	Pd	114	Ag
40	Zr	108	Nb	109	Mo	110	Tc	111	Ru	112	Rh	113	Pd	114	Ag	115	Cd
41	Nb	109	Mo	110	Tc	111	Ru	112	Rh	113	Pd	114	Ag	115	Cd	116	In
42	Mo	110	Tc	111	Ru	112	Rh	113	Pd	114	Ag	115	Cd	116	In	117	Sn
43	Tc	111	Ru	112	Rh	113	Pd	114	Ag	115	Cd	116	In	117	Sn	118	Sb
44	Ru	112	Rh	113	Pd	114	Ag	115	Cd	116	In	117	Sb	118	Sn	119	Te
45	Rh	113	Pd	114	Ag	115	Cd	116	In	117	Sb	118	Sn	119	Te	120	Bi
46	Pd	114	Ag	115	Cd	116	In	117	Sb	118	Sn	119	Te	120	Bi	121	Po
47	Ag	115	Cd	116	In	117	Sb	118	Sn	119	Te	120	Bi	121	Po	122	At
48	Cd	116	In	117	Sb	118	Sn	119	Te	120	Bi	121	Po	122	At	123	Rn
49	In	117	Sb	118	Sn	119	Te	120	Bi	121	Po	122	At	123	Rn	124	Fr
50	Sn	118	Sb	119	Te	120	Bi	121	Po	122	At	123	Rn	124	Fr	125	Ra
51	Sb	119	Te	120	Bi	121	Po	122	At	123	Rn	124	Fr	125	Ra	126	Ac
52	Te	120	Bi	121	Po	122	At	123	Rn	124	Fr	125	Ra	126	Ac	127	Th
53	Bi	121	Po	122	At	123	Rn	124	Fr	125	Ra	126	Ac	127	Th	128	Pa
54	Po	122	At	123	Rn	124	Fr	125	Ra	126	Ac	127	Th	128	Pa	129	U
55	At	123	Rn	124	Fr	125	Ra	126	Ac	127	Th	128	Pa	129	U	130	Np
56	Rn	124	Fr	125	Ra	126	Ac	127	Th	128	Pa	129	U	130	Np	131	Pu
57	Fr	125	Ra	126	Ac	127	Th	128	Pa	129	U	130	Np	131	Pu	132	Am
58	Ra	126	Ac	127	Th	128	Pa	129	U	130	Np	131	Pu	132	Am	133	Cm
59	Ac	127	Th	128	Pa	129	U	130	Np	131	Pu	132	Am	133	Cm	134	Bk
60	Th	128	Pa	129	U	130	Np	131	Pu	132	Am	133	Cm	134	Bk	135	Cf
61	Pa	129	U	130	Np	131	Pu	132	Am	133	Cm	134	Bk	135	Cf	136	Es
62	U	130	Np	131	Pu	132	Am	133	Cm	134	Bk	135	Cf	136	Es	137	Fm
63	Np	131	Pu	132	Am	133	Cm	134	Bk	135	Cf	136	Es	137	Fm	138	Mn
64	Pu	132	Am	133	Cm	134	Bk	135	Cf	136	Es	137	Fm	138	Mn	139	Nb
65	Am	133	Cm	134	Bk	135	Cf	136	Es	137	Fm	138	Mn	139	Nb	140	Mo
66	Cm	134	Bk	135	Cf	136	Es	137	Fm	138	Mn	139	Nb	140	Mo	141	Tc
67	Bk	135	Cf	136	Es	137	Fm	138	Mn	139	Nb	140	Mo	141	Tc	142	Ru
68	Cf	136	Es	137	Fm	138	Mn	139	Nb	140	Mo	141	Tc	142	Ru	143	Rh
69	Es	137	Fm	138	Mn	139	Nb	140	Mo	141	Tc	142	Ru	143	Rh	144	Pd
70	Fm	138	Mn	139	Nb	140	Mo	141	Tc	142	Ru	143	Rh	144	Pd	145	Ag
71	Mn	139	Nb	140	Mo	141	Tc	142	Ru	143	Rh	144	Pd	145	Ag	146	Cd
72	Nb	140	Mo	141	Tc	142	Ru	143	Rh	144	Pd	145	Ag	146	Cd	147	In
73	Mo	141	Tc	142	Ru	143	Rh	144	Pd	145	Ag	146	Cd	147	In	148	Sn
74	Tc	142	Ru	143	Rh	144	Pd	145	Ag	146	Cd	147	In	148	Sn	149	Sb
75	Ru	143	Rh	144	Pd	145	Ag	146	Cd	147	In	148	Sn	149	Sb	150	Te
76	Rh	144	Pd	145	Ag	146	Cd	147	In	148	Sn	149	Sb	150	Te	151	Bi
77	Pd	145	Ag	146	Cd	147	In	148	Sn	149	Sb	150	Te	151	Bi	152	Po
78	Ag	146	Cd	147	In	148	Sn	149	Sb	150	Te	151	Bi	152	Po	153	At
79	Cd	147	In	148	Sn	149	Sb	150	Te	151	Bi	152	Po	153	At	154	Rn
80	In	148	Sn	149	Sb	150	Te	151	Bi	152	Po	153	At	154	Rn	155	Fr
81	Sb	150	Te	151	Bi	152	Po	153	At	154	Rn	155	Fr	156	Ra	157	Ac
82	Te	151	Bi	152	Po	153	At	154	Rn	155	Fr	156	Ra	157	Ac	158	Th
83	Bi	152	Po	153	At	154	Rn	155	Fr	156	Ra	157	Ac	158	Th	159	Pa
84	Po	153	At	154	Rn	155	Fr	156	Ra	157	Ac	158	Th	159	Pa	160	U
85	At	154	Rn	155	Fr	156	Ra	157	Ac	158	Th	159	Pa	160	U	161	Np
86	Rn	155	Fr	156	Ra	157	Ac	158	Th	159	Pa	160	U	161	Np	162	Pu
87	Fr	156	Ra	157	Ac	158	Th	159	Pa	160	U	161	Np	162	Pu	163	Am
88	Ra	157	Ac	158	Th	159	Pa	160	U	161	Np	162	Pu	163	Am	164	Cm
89	Ac	158	Th	159	Pa	160	U	161	Np	162	Pu	163	Am	164	Cm	165	Bk
90	Th	159	Pa	160	U	161	Np	162	Pu	163	Am	164	Cm	165	Bk	166	Cf
91	Pa	160	U	161	Np	162	Pu	163	Am	164	Cm	165	Bk	166	Cf	167	Es
92	U	161	Np	162	Pu	163	Am	164	Cm	165	Bk	166	Cf	167	Es	168	Fm
93	Np	162	Pu	163	Am	164	Cm	165	Bk	166	Cf	167	Es	168	Fm	169	Mn
94	Pu	163	Am	164	Cm	165	Bk	166	Cf	167	Es	168	Fm	169	Mn	170	Nb
95	Am	164	Cm	165	Bk	166	Cf	167	Es	168	Fm	169	Mn	170	Nb	171	Mo
96	Cm	165	Bk	166	Cf	167	Es	168	Fm	169	Mn	170	Nb	171	Mo	172	Tc
97	Bk	166	Cf	167	Es	168	Fm	169	Mn	170	Nb	171	Mo	172	Tc	173	Ru
98	Cf	167	Es	168	Fm	169											



CERTIFICATE OF ANALYSIS

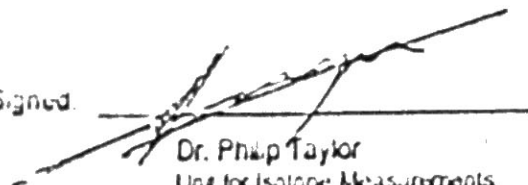
ERM[®] - AE639

Hg in a solution of 0.5 M HCl + 0.05 % (m/v) K ₂ Cr ₂ O ₇			
		Certified value ¹	Uncertainty ²
amount content	mol (²⁰² Hg) · g ⁻¹ (solution)	1.189 1 · 10 ⁻⁸	0.005 0 · 10 ⁻⁸
amount ratios	$n(^{160}\text{Hg})/n(^{202}\text{Hg})$	0.004 972	0.000 046
	$n(^{162}\text{Hg})/n(^{202}\text{Hg})$	0.330 6	0.002 1
	$n(^{164}\text{Hg})/n(^{202}\text{Hg})$	0.561 9	0.002 8
	$n(^{200}\text{Hg})/n(^{202}\text{Hg})$	0.770 5	0.002 8
	$n(^{201}\text{Hg})/n(^{202}\text{Hg})$	0.441 26	0.000 88
	$n(^{204}\text{Hg})/n(^{202}\text{Hg})$	0.230 27	0.000 75
<p>1) The values of the Hg isotope ratios are traceable to the SI via the values of the Tl isotope ratios of the isotopic reference material NIST SRM 977. The Hg content of the natural isotopic species is traceable to Hg amount content measurements based on gravimetry, whereby a mass of pure substance (Hg₂Cl₂) was weighed and corrections were made for impurities.</p> <p>2) Estimated expanded uncertainty U with a coverage factor k=2, corresponding to a level of confidence of about 95 %, as defined in the Guide to the Expression of Uncertainty in Measurement (GUM), ISO, 1995.</p>			

This certificate is valid until 6/2014; this validity may be extended as further evidence of stability becomes available. The material can be regarded as a homogeneous solution.

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revised December 2006

Signed



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NOTE

European Reference Material ERM[®]-AE639 was originally certified as IRMM-639. It was produced and certified under the responsibility of the IRMM according to the principles laid down in the technical guidelines of the European Reference Materials[®] co-operation agreement between BAM-IRMM-LGC. Information on these guidelines is available on the Internet (<http://www.erm-crm.org>). A detailed technical report on the certification procedure can be found in IRMM Internal Report GE/R/IM/40/99, available from IRMM on explicit request.

DESCRIPTION OF THE SAMPLE

The Spike Isotopic Reference Material ERM[®]-AE639 is supplied with a certified isotope amount content of ²⁰²Hg. The samples are supplied in flame-sealed glass ampoules and contain about 0.2 μmol of mercury in 5 mL of a hydrochloric acid solution. The matrix is 0.5 M sub-boiling distilled hydrochloric acid + 0.05 % (m/v) potassium dichromate.

From the certified values, the following amount and mass contents, the isotopic composition of Hg and the molar mass are derived:

		Certified value	$U(k=2)^1$
amount content	mol (Hg) · g ⁻¹ (solution)	$3.971 \cdot 10^{-6}$	$0.015 \cdot 10^{-6}$
mass content	g (²⁰² Hg) · g ⁻¹ (solution)	$2.402 \cdot 10^{-6}$	$0.010 \cdot 10^{-6}$
	g (Hg) · g ⁻¹ (solution)	$7.966 \cdot 10^{-6}$	$0.030 \cdot 10^{-6}$
isotope amount fractions of Hg (·100)	$n(^{196}\text{Hg})/n(\text{Hg})$	0.148 9	0.001 3
	$n(^{198}\text{Hg})/n(\text{Hg})$	9.900	0.052
	$n(^{199}\text{Hg})/n(\text{Hg})$	16.826	0.064
	$n(^{200}\text{Hg})/n(\text{Hg})$	23.073	0.058
	$n(^{201}\text{Hg})/n(\text{Hg})$	13.213	0.025
	$n(^{202}\text{Hg})/n(\text{Hg})$	29.944	0.053
	$n(^{204}\text{Hg})/n(\text{Hg})$	6.895	0.030
isotope mass fractions of Hg (·100)	$m(^{196}\text{Hg})/m(\text{Hg})$	0.145 4	0.001 2
	$m(^{198}\text{Hg})/m(\text{Hg})$	9.769	0.052
	$m(^{199}\text{Hg})/m(\text{Hg})$	16.689	0.064
	$m(^{200}\text{Hg})/m(\text{Hg})$	23.000	0.058
	$m(^{201}\text{Hg})/m(\text{Hg})$	13.237	0.025
	$m(^{202}\text{Hg})/m(\text{Hg})$	30.148	0.053
	$m(^{204}\text{Hg})/m(\text{Hg})$	7.011	0.030
molar mass of Hg	g · mol ⁻¹	200.604 1	0.003 2

¹All uncertainties indicated are expanded uncertainties $U = k \cdot u_c$ where u_c is the combined standard uncertainty estimated following the ISO/BIPM Guide to the Expression of Uncertainty in Measurement.

Atomic masses used for calculation of the derived values:

G. Audi and A. H. Wapstra, The 1993 atomic mass evaluation, *Nucl Phys A565* (1993) 1-65.

Isotope	$g \cdot mol^{-1}$	$U (k=2)$
^{196}Hg	195.965 814	0.000 008
^{198}Hg	197.966 752	0.000 006
^{199}Hg	198.968 262	0.000 006
^{200}Hg	199.968 309	0.000 006
^{201}Hg	200.970 285	0.000 006
^{202}Hg	201.970 625	0.000 006
^{204}Hg	203.973 475	0.000 006

ANALYTICAL METHOD USED FOR CERTIFICATION

The mercury mass fraction was calculated from gravimetric data, taking results from impurity measurements and uncertainties into account. The isotopic composition was determined by ICP-MS.

PARTICIPANTS

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SAFETY INFORMATION

The usual laboratory safety precautions apply

INSTRUCTIONS FOR USE

Using this spike isotopic reference material, the Hg content in an unknown sample can be determined by Isotope Dilution, through a measurement of the mercury isotope amount ratio $R(B) = n(^{200}Hg)/n(^{202}Hg)$, in a blend. It should be calculated with the aid of the following equation, which enables an easy quantification of the uncertainty sources in the procedure:

$$c(Hg, X) = \frac{R(Y) - R(B)}{R(B) - R(X)} \cdot \frac{\sum R_i(X)}{\sum R_i(Y)} \cdot \frac{m(Y)}{m(X)} \cdot c(Hg, Y)$$

where:

- $R(X)$ = amount ratio $n(^{200}Hg)/n(^{202}Hg)$ in the unknown sample material X
- $R(Y)$ = amount ratio $n(^{200}Hg)/n(^{202}Hg)$ in the spike material Y
- $\sum R_i(X)$ = sum of all amount ratios in the unknown sample material X
- $\sum R_i(Y)$ = sum of all amount ratios in the spike material Y
- $m(X)$ = mass of unknown sample used in the measurement
- $m(Y)$ = mass of the sample of spike solution used in the measurement
- $c(Hg, X)$ = amount content of Hg $\cdot g^{-1}$ sample material
- $c(Hg, Y)$ = amount content of Hg $\cdot g^{-1}$ spike solution

STORAGE

The material may be stored at 18 °C in the dark.

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Спектрограмма №18

