INSTITUTE OF NON-FERROUS METALS

Analytical Chemistry Department
44-101 Gliwice, ul. Sowińskiego 5

CERTIFICATE OF ANALYSIS

Copper of high purity

The average results of chemical analyses in wt %

No. / Element	CP 1	CP 2	CP 3	CP 4	CP 5	CP 6
Pb	0,00017	0,012	0,0081	0,0028	0,0013	0,00027
Sb	0,0011	0,016	0,012	0,0048	0,0027	0,00004
As	0,00004	0,014	0,0063	0,0014	0,0065	0,000085
Si	-----	(0,0004)	(0,0008)	(0,0003)	(0,0082)	----
Zn	0,00019	0,0092	0,0033	0,0017	0,0038	0,00014
Ag	0,0012	0,0036	0,0060	0,011	0,0031	0,0020
Mn	0,00013	0,00059	0,0030	0,0055	0,0049	0,00006
Co	0,00002	0,0039	0,0020	0,00042	0,0034	< 0,0001
Cr	0,00003	0,00005	0,0045	0,0086	0,0048	0,00003
S	0,00063	0,0035	0,0060	0,0094	0,0021	0,00075
Fe	0,0010	0,00081	0,0015	0,0044	0,0077	0,00064
Cd	0,00006	0,0072	0,0035	0,0011	0,00025	-----
Sn	0,00056	0,00048	0,0017	0,0040	0,00021	0,00007
P	0,00020	0,0011	0,0044	0,013	0,011	0,00017
Se	< 0,0001	0,0077	0,0043	0,0010	0,0035	< 0,0001
Ni	0,00034	0,0020	0,0013	0,00034	0,0039	0,00027
Te	0,00030	0,0012	0,0046	0,0075	0,00078	-----
Bi	0,00010	-----	0,0047	0,0013	0,00094	-----

Gliwice 1994

Director of the Institute

Prof. Ph.D. Zbigniew Śmieszek

The confidence intervals in wt % at the probability level of 0,05

No. / Element	CP 1	CP 2	CP 3	CP 4	CP 5	CP 6
Pb	0,000018	0,00048	0,00022	0,00014	0,000050	0,000033
Sb	0,000073	0,00060	0,00034	0,00025	0,00013	0,000011
As	0,000012	0,00052	0,00012	0,000062	0,00015	0,000013
Si	------	-------	------	------	------	------
Zn	0,000032	0,00024	0,00018	0,00019	0,00020	0,000012
Ag	0,000079	0,00011	0,00017	0,00079	0,00011	0,00013
Mn	0,000018	0,000023	0,000068	0,00017	0,00014	0,000016
Co	0,0000086	0,00024	0,00018	0,000036	0,00025	------
Cr	0,0000085	0,0000086	0,00021	0,00031	0,00019	0,000012
S	0,000030	0,00017	0,00018	0,00033	0,000085	0,000057
Fe	0,000066	0,000061	0,000087	0,00011	0,00013	0,000076
Cd	0,0000065	0,00018	0,000089	0,000036	0,000021	------
Sn	0,000053	0,000049	0,00016	0,00034	0,000023	0,0000037
P	0,000039	0,000065	0,00028	0,00049	0,00069	0,000031
Se	------	0,00037	0,00011	0,000061	0,00021	------
Ni	0,000026	0,0000045	0,000067	0,000023	0,000077	0,000026
Te	0,000049	0,00052	0,00011	0,00027	0,000045	------
Bi	0,000053	------	0,00037	0,000067	0,000069	------

Analytical methods applied:

Pb - AAS directly and after co-precipitation on Fe(OH)3 (pH 9) and after electrolysis Cu, ICP-AES, AES-direct current arc, spark "trace";

Sb - AAS after co-precipitation on Fe(OH)3 (pH 4), ICP-AES, AES-direct current arc, spark "trace", DCP after co-precipitation on La(OH)3;

As - AAS after co-precipitation on Fe(OH)3 (pH 4), ICP-AES, AES-direct current arc, spark "trace", DCP after co-precipitation on La(OH)3;

Si - spectrophotometric after extraction, AAS, ICP-AES;

Zn - AAS directly and after electrolysis Cu, ICP-AES, AES-direct current arc, spark "trace";

Ag - AAS directly, titration, ICP-AES, AES-direct current arc, spark "trace";

Mn - AAS directly and after electrolysis Cu, ICP-AES, AES-direct current arc, spark "trace";

S - titration, method of combusting and infrared determination of SO_2, ICP-AES, AES-direct current arc, spark "trace";

Co - AAS directly and after electrolysis Cu, spectrophotometric after electrolysis Cu, ICP-AES, AES-direct current arc, spark "trace";

Cr - AAS directly and after electrolysis Cu, ICP-AES, DCP after electrolysis Cu;

Se - AAS after co-precipitation on $Fe(OH)_3$ (pH 4), ICP-AES, AES-direct current arc, spark "trace", DCP after co-precipitation on $La(OH)_3$;

Ni - AAS after electrolysis Cu, ICP-AES, AES-direct current arc, spark "trace", spectrophotometric after electrolysis Cu;

Te - AAS after co-precipitation on $Fe(OH)_3$ (pH 4), ICP-AES, AES-direct current arc, spark "trace", DCP-after co-precipitation on $La(OH)_3$;

Bi - AAS after co-precipitation on $Fe(OH)_3$ (pH 4) and after co-precipitation on $La(OH)_3$, ICP-AES, AES-direct current arc, spark "trace";

P - spectrophotometric after extraction, titration, ICP-AES, AES-direct current arc, spark "trace";

Sn - AAS after co-precipitation on $Fe(OH)_3$, spectrophotometric after co- precipitation on MnO_2, ICP-AES, AES-direct current arc, spark "trace", DCP after co-precipitation on $La(OH)_3$;

Cd - AAS directly and after electrolysis Cu, ICP-AES, AES-direct current arc, spark "trace';

Fe - AAS directly and after co-precipitation on $La(OH)_3$, AAS after electrolysis Cu, ICP-AES, AES-direct current arc, spark "trace";

The chemical analyses have been carried out in four specialistic industrial laboratories, two from Poland (WM"Dziedzice", HM"Szopienice") and two from Germany (Norddeutsche Affinerie, Huttenwerke Kayser AG) and in laboratory of the Institute of Non-Ferrous Metals using minimal, when possible, three different methods.

Melts have been performed using vacuum furnace. Copper CRMs have form of discs 40 mm in diameter and 23 mm in height.

Homogeneity investigations were made taking into account over 30 % of the material produced. Investigations were carried out using atomic emission spectrometry method with low voltage spark. Homogeneity was estimated statistically with application of the test F.

Materials have been produced and certified with the requirements of ISO Guide 31, ISO Guide 34, and ISO Guide 35.

CRMs CP series is in accordance with CRMs CS series produced by Institute of Non-Ferrous Metals.

Application of CRMs - Atomic emission spectrometry

CRMs are stable in time