INSTITUTE OF NON-FERROUS METALS

Analytical Chemistry Department
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CERTIFICATE OF ANALYSIS

Copper of high purity

The average results of chemical analysis in ppm

No. / Element	CS1	CS2	CS3	CS4	CS5
Ag	53,1	45,6	38,9	237,0	320,0
As	2,3	7,9	13,8	42,2	70,5
Bi	1,1	6,2	12,2	39,6	59,7
Cd	1,0	7,4	13,4	35,5	66,1
Fe	18,4	30,5	28,3	82,0	90,9
Ni	46,8	26,7	11,1	7,2	4,4
Pb	60,5	38,6	13,3	7,6	5,0
Sb	3,0	7,5	13,0	36,8	63,9
Se	61,5	39,0	15,4	6,7	0,9
Sn	52,9	33,7	13,3	6,2	0,85
Te	2,1	5,6	10,6	32,9	49,9
Zn	24,1	8,9	31,3	44,0	100,6
Co	0,6	3,6	7,4	24,3	37,5
B	(1,1)	(2,8)	(4,2)	(21,7)	(35,2)
Mn	29,0	35,3	12,6	8,3	4,3
S	65,9	44,9	18,8	41,3	12,0
Cr	(0,3)	35,8	10,9	7,0	1,0
P	57,7	33,8	12,1	6,3	2,0
Si	(3,0)	(9,4)	(22,2)	(46,5)	(54,8)

Director of the Institute

Prof. Ph.D. Zbigniew Śmieszek

The uncertainity in ppm at the probability level of 0,05

No. / Element	CS1	CS2	CS3	CS4	CS5
Ag	2,1	1,8	1,9	22,6	18,8
As	0,6	0,7	1,6	2,5	3,6
Bi	0,1	0,6	1,0	1,7	2,5
Cd	0,1	0,3	0,3	1,1	1,9
Fe	0,6	1,6	1,7	1,6	4,7
Ni	0,9	1,7	0,3	0,5	0,6
Pb	1,2	0,8	1,0	0,7	0,4
Sb	0,3	1,0	1,2	2,9	2,0
Se	7,3	3,7	2,8	0,7	0,1
Sn	1,9	2,6	0,6	0,5	0,1
Te	0,9	0,4	1,0	2,5	5,1
Zn	2,1	1,0	2,7	2,7	3,9
Co	0,3	0,3	0,2	1,2	2,0
B	-	-	-	-	-
Mn	2,0	1,6	0,6	0,7	0,7
S	2,2	2,5	1,9	1,6	1,3
Cr	-	0,8	1,0	0,3	0,2
P	5,4	3,8	0,8	0,3	0,7
Si	-	-	-	-	-

Analytical methods applied:

Ag - atomic emission spectrometry with ICP and low voltage spark,
atomic absorption spectrometry directly on the background of matrix

As - atomic emission spectrometry with ICP and low voltage spark,
atomic absorption spectrometry after co-precipitation on $Fe(OH)_3$ (pH4)

Bi - atomic emission spectrometry with ICP and low voltage spark,
atomic absorption spectrometry after co-precipitation on $Fe(OH)_3$ (pH4)

Cd - atomic emission spectrometry with ICP and low voltage spark,
atomic absorption spectrometry directly on the background of matrix

Fe - atomic emission spectrometry with ICP and low voltage spark,
atomic absorption spectrometry after co-precipitation on $La(OH)_3$ (pH9)

Ni - atomic emission spectrometry with ICP and low voltage spark,
spectrophotometric with dimethylgliyoxime after electrolytic
copper separation and extraction of Ni with chloroform

Pb - atomic emission spectrometry with ICP and low voltage spark,
atomic absorption spectrometry after co-precipitation on $Fe(OH)$ (pH9)

Sb - atomic emission spectrometry with ICP and low voltage spark, atomic absorption spectrometry after co-precipitation on $Fe(OH)_3$ (pH4)

Se - atomic emission spectrometry with ICP and low voltage spark, atomic absorption spectrometry after co-precipitation on $Fe(OH)_3$ (pH4)

Sn - atomic emission spectrometry with ICP and low voltage spark, spectrophotometric with phenylophluoran after separation on MnO_2

Te - atomic emission spectrometry with ICP, atomic absorption spectrometry after co-precipitation on $Fe(OH)_3$ (pH4)

Zn - atomic emission spectrometry with ICP and low voltage spark, atomic absorption spectrometry after electrolytic copper separation

Co - atomic emission spectrometry with ICP, atomic absorption spectrometry directly or after electrolytic copper separation

B - atomic emission spectrometry with ICP, spectrophotometric (directly) with azomethine H

Mn - atomic emission spectrometry with ICP and low voltage spark, atomic absorption spectrometry directly on the background of matrix

S - atomic emission spectrometry with ICP and low voltage spark, method of combusting and infrared determination of SO_2

Cr - atomic emission spectrometry with ICP and low voltage spark, atomic absorption spectrometry directly on the background of matrix

P - atomic emission spectrometry with ICP and low voltage spark, spectrophotometric with blue-phosphoromolibdenate after extraction

Si - atomic emission spectrometry with ICP, spectrophotometric with amyl-alcohol

The chemical analysis have been carried out in four specialistic industrial laboratories from Poland and in two laboratories of the Institute of Non-Ferrous Metals using when possible three different methods. Melts have been performed using vacuum furnace.

Copper CRMs after extrusion have form a of discs 40 mm in diameter and 25 mm in height or 6 mm in diameter and 100 mm long.

Homogeneity investigations were made taking into account 30 % of the material produced. Investigations were carried out the using atomic emission spectrometry method with low voltage spark.

Homogeneity was estimated statistically with application of the test F.

Application of CRMs – Atomic emission spectrometry.

CRMs are stable in time.