SUPER-PURE   OXYGEN-FREE COPPER   Some characteristics

ELECTRICAL   CONDUCTIVITY, t = 20⁰ C

Not all methods, the equipment and qualification allow to measure chemical purity of copper equally. Especially it concerns purity of 5N+ and above. Also, if physical characteristic is required, it will be impossible to tell precisely about it by means of only the chemical analysis, especially in cryogenics. Direct measuring of characteristic is required.

Testing

We have tested the electrical conductivity of various 2 samples from each of 6 ingots describing fluctuations of a chemical compound of the **BASIC** quality**.** The copper wire of grade M006 (manufactured in 80th years, the USSR) also was measured for the control of conditions of measuring and as the known standard for comparison.

Annealing and measuring have been made by two groups. In each group there was one sample from each ingot and M006 wire. Random numbering has been carried out before an annealing and measuring to prevent an unintentional adapting or regulation of results. At the measurement, what sample should be better or worse it was not known.

Measuring was carried out with equipment appropriate to this problem. After measuring, samples was renumbered to the expected results sequence based on the analysis of impurities. The received results practically have coincided with the expected results that also there is an attribute of qualitative measurement and predictability of quality of our product.

Results of testing

Results are presented below, + / - is specified in relation to the sample #6, to the best of a chemical compound.

Electrical conductivity, % IACS. (T=20⁰ C, annealed)							
#	M006	1, min	2	3	4	5	6, max
Test 1	102,08	103,93	104,05	104,05	104,30	104,18	104,24
+ / -		-0,31	-0,19	-0,19	0,06	-0,06	0,00
Test 2	102,26	104,68	105,00	105,00	105,00	105,07	105,13
+ / -		-0,45	-0,13	-0,13	-0,13	-0,06	0,00
Avg	**102,17**	**104,31**	**104,53**	**104,53**	**104,65**	**104,63**	**104,69**
+ / -		-0,38	-0,16	-0,16	-0,03	-0,06	**0,00**

Or graphically:
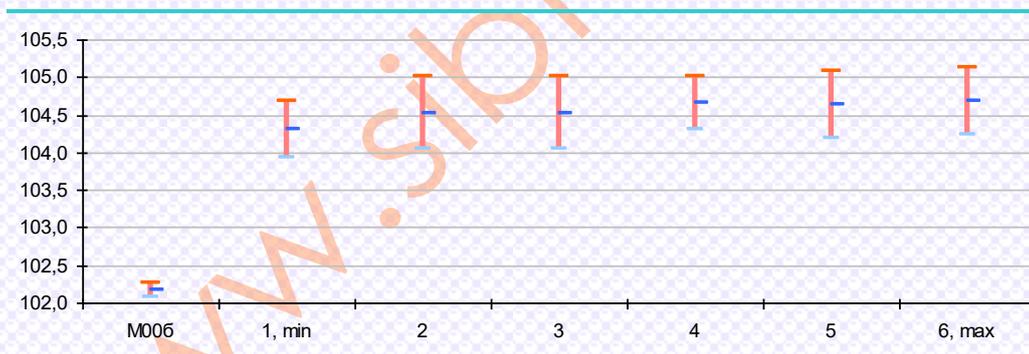
Electrical conductivity is 104-105% IACS. Results of two series differ a little. It is possible to explain it by some difference in annealing and also by calculations of conductors profiles. The result for M006 is such what should be and our results look real. Results are within the limits of expected and how it has become known later the results do not contradict other data: some various sources assert that electrical conductivity for pure "correct copper of 99,999%" is not less ~103, 4-6% IACS and RRR > 1000. For our copper, RRR is expected more greater than it. RRR for C10100 ~200-250.

Also the Institute of Applied Physics of the Russian Academy of Science has made the measuring of reflectance of our sample at 0-300K. The result was also very high and close to calculations for « theoretical copper ».

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Interpretation of test results for an experimental

Representative sample was formed on the basis of the enough of chemical analyses describing fluctuations of a chemical compound of the **BASIC** quality of the experimental product. At sampling, the known various influence of various impurities on electric conductivity also was considered. It was verified and was traced that also is an attribute of quality of sampling and measuring. The structure of ingots of samples is close or identical to other ingots. Maximal electrical conductivity of samples is G (max; samples) =G o ∈ [104,24; 105,13].

Statistical distribution of deviation of electrical conductivity from G o for experimental lots :

Grade \ Result		1, min	2-3	4-5	6, max	*
		[-045;-0,20)	[-0,20;-0,10)	[-0,10;-0,00)	~0:+/-0,05	+?
Extra Typical				10	60	30
Extra	~%		20	20	40	20
Basic Typical			45	30	25	
Basic		15	40	25	20	
Basic + Ag (Ag ≤ 5 ppm)		10	30	40	20	

Or graphiclly:
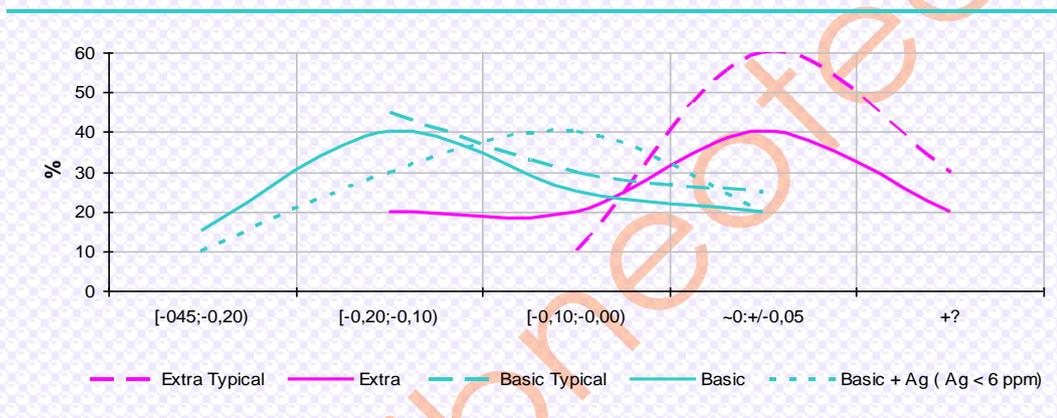
The measurement results adequately reflect these characteristics of ultrapure copper for the experimental batch. In other words, with approximately such a probability, an ingot from a subgroup of the specified quality from the entire experimental batch can be selected. The results are even underestimated.