LLC "Sibneotech"
Novosibirsk, Russia 630058 , Plotinnaya St. 2/6

OXYGEN-FREE COPPER 99,999 + %.
SOME RESULTS of RESEARCHES in graphic charts

Two samples of copper are investigated, ones of classical oxygen-free (BC) copper (99.97 % Cu), and another is specially pure oxygen-free copper (99,999 % Cu) produced of LLC "Sibneotech" (ultra-pure).

Article 1. Precision Resonator methods dielectrics and metals in the frequency range of 40 GHz – 500 GHz and in the temperature range of 4K-900K
V.V. Parshin, E.A. Serov
Institute of Applied Physics RAS (PAH)

Losses on reflection to copper and beryllium sample 230 GHz frequency *(almost "fell" in the calculated curve.)*

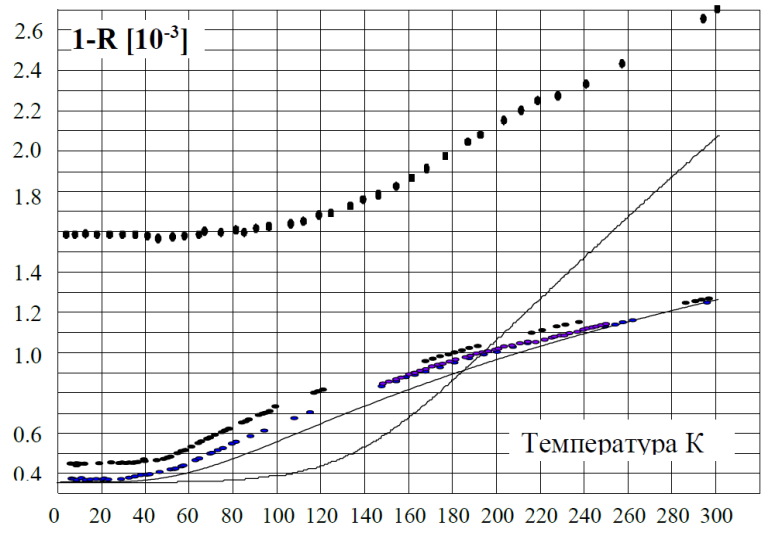

Рисунок 4

Figure 4. Those are the first results of research on mirrors from ultra-purified copper (0.99999) and beryllium mirrors….. Solid curves calculation accordingly for pure beryllium and copper. One can see that for **ultra-pure copper** (the top point to the annealing in hydrogen) with helium and room temperatures are close to the acquirer, and for beryllium mirrors substantially above both at room and, specifically at low temperatures. The result is logical, because it was not pure beryllium, but its alloy containing only 97.8% Be.

Article 2. Reflectance of metals in the millimeter range of wavelengths at cryogenic temperatures.
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[1] *Institute of Applied Physics RAS*
[2] *Nizhny Novgorod State Technical University n.a R.E Alekseev*

Reflection loss for copper samples at a frequency of 190-250, averaging GHz

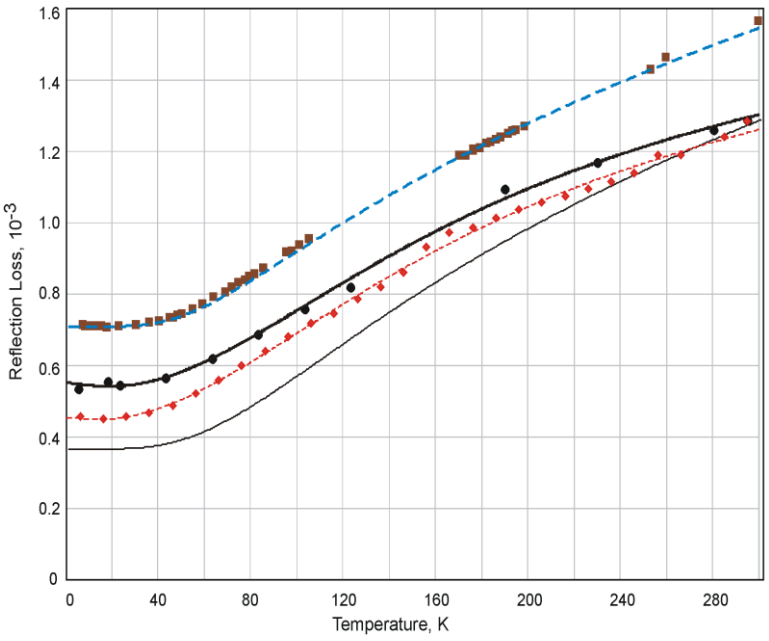


Figure. Reflection loss for copper specimens at 230 GHz frequency depending on the temperature. Thin solid line – calculation for pure copper with taking into account anomalous skin effect. Squares – recalculation of the experimental dependence obtained for sample BC copper at 150 GHz (see text), bold dashes line is the approximation of this dependence model using formulas (20), (21), (24). Circles – the experimental dependence of **ultra-pure copper** sample (averaging over several frequencies in the range 190-250 GHz), big solid curve – approximation of that dependency (see text), rhomb – the experimental dependence for ultra-pure sample from copper after annealing in hydrogen (averaging over several frequencies in the range 190-250 GHz), the thin dashed line – approximation of that dependence (see text).

Perfunctory resistance of copper at 13.6 GHz

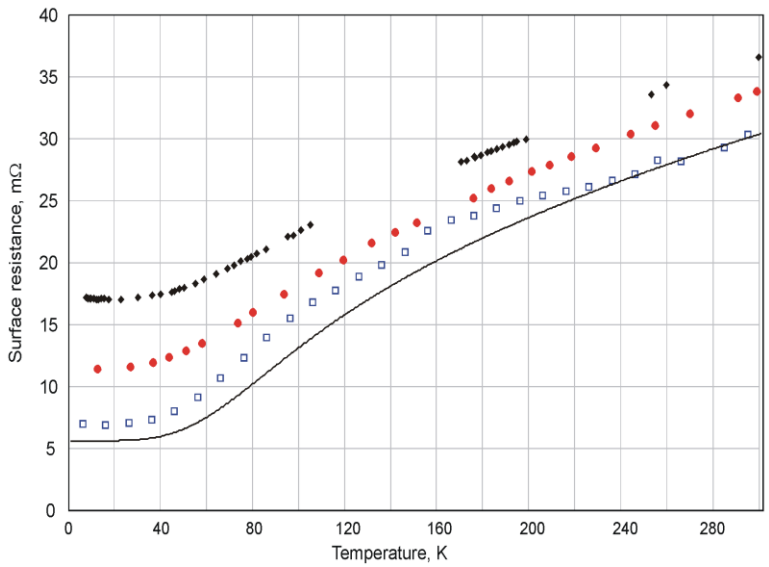
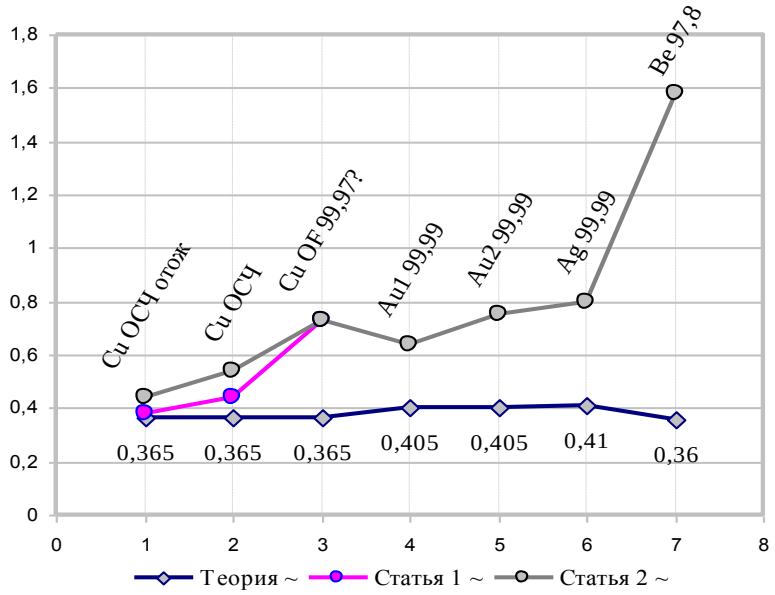


Figure. Perfunctory resistance of copper (IOM) at 13.6 GHz depending on temperature. Thin solid line – calculation for pure copper with taking into account anomalous skin effect. Rhomb – recalculation of the experimental dependence obtained for BC copper at 150 GHz, Circles – experimental data on copper BC from work **[22]**, squares – recalculation of experimental dependencies obtained for **ultra-pure copper** after annealing in hydrogen in the frequency range 190-250 GHz.

22.S.Inagaki,E.Ezura, J.-F. Liu, H. Nakanishi, "Thermal expansion and microwave surface reactance of copper from the normal to anomalous skin effect region," *J. Appl. Phys.*, vol. 82, no. 11 5401-5410, 1997.

Some summarized results of Article 1 and 2.



Some comparison of results of Articles 1 both 2 and some other results on frequencies of 190-250 GHz at ~ 0-40K.

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Cu ОСЧ - Cu OF 99.999+% / ultra-pure copper of LLC "Sibneotech ".
Cu ОСЧ отож - annealed Cu OF 99.999+%
Теория - Theory
Статья 1 - Article 1
Статья 2 - Article 2

The result of measuring (loss on reflection) in the first article (the measuring nearly "fell" on the calculated curve) is better, than in the second. The second article describes the average results of several measurements in the range 190-250 GHz. Measuring are on the limit of equipments and of physical **characteristics of copper**, measured values are very small, surface quality has significant impact, etc., and it requires a certain amount of caution in the process of measurement and the formation of the final results. Anyway, the results in both articles are a very high level and extremely close to expected results.

Characteristics such as RRR and Thermal conductivity are expected at the similar high level. These characteristics are expected to be 5-10 times higher than those for brands M0b, M00b, C10200, C10100.

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