THE MEMBERSHIP OF THE LENGTH UNITS IN THE FIELD OF MEASUREMENTS OF GEOMETRIC PARAMETERS OF DEVIATION FROM PLANE

V. Lysenko, V. Kupko, D. Novikov, A. Lavrukhin, A. Shukufa, E. Iskenderzade

Abstract: The results of the international comparison of the standards from flatness in accordance with the COOMET D9/2018 program are considered. The comparison includes SC "Institute of Metrology" (Ukraine), VNIIMS (Russia) and BelGIM.

Keywords: Comparison, standards for flatness, uncertainty.

Introduction

In accordance with the programme of comparisons of COOMET D9/2018 for 2018 has been scheduled supplementary comparisons of standards of flatness on the topic of KOOMET 570/UA/12 (COOMET.L-S15).

Laboratory pilot - NSC "Institute of Metrology" (Ukraine).

The standard of comparison-a measure of deviations from flatness was provided by VNIIMS (Russia).

The purpose of comparisons is to establish the degree of equivalence of national standards.

The scheme of comparisons – circular.

Principle of comparison.

Participants of comparison shall carry out on their national standards measurements of the standard of comparison of diameter 200 mm, thickness 30 mm (hereinafter - measure) in accordance with the requirements of the technical Protocol section "Instructions for measurements" and instructions for working with national standards.

The results obtained are calculated:

– reference value of the deviation from the flatness of the measure;

– the expanded uncertainty of the reference value.

Comparison standard

As a standard of comparison, the measure of flatness (in the package) shown in figure 1 belonging to VNIIMS was used.

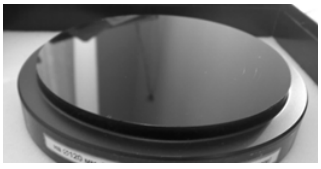

Figure 1 – External view of the standard of comparison

3 method of measurement

Measurement of the deviation from the flatness of the measure was performed by interference method.

The deviation from the flatness of the measure was determined by the bending of the interference fringes.

Brief description of standards

The BelGIM reference interference facility was created on the basis of if-77. The General view of the standard is shown in figure 2.

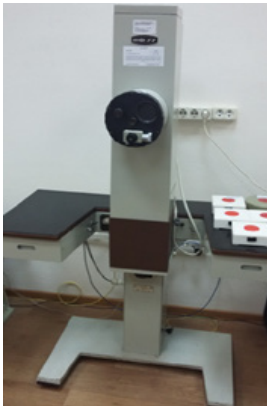

Fig.2-General view of the BelGIM standard

The interference installation of if-77 has the following metrological and technical characteristics:

The maximum permissible error of 0.05 installation interference fringe patterns.

The limit of permissible standard deviation of the random component of the basic error 0.02 of the interference fringe.

The radiation source is a helium-neon optical quantum generator LG-56 (wavelength $\lambda = 0.6328$ μm).

As a reference VNIIMS were used: automated photoelectric measuring system based on Fizeau interferometer, part of get 183-2010.

The General view of the VNIIMS standard is shown in figure 3.

Fig.3 - General view of the VNIIMS standard

The automated photoelectric measuring unit based on the Fizo interferometer has the following metrological and technical characteristics:

1 linear field of view Diameter 300 mm.

2 the expanded uncertainty of measurements on the 100 mm diameter of 2.4 nm.

3 RMS of the measurements is 0.4 nm.

4 the radiation Source is a helium-neon laser (wavelength = 0.6328 μm).

NSC " IM " conducted comparisons of the comparison standard on the interference installation if-77 included in the state primary standard of the unit of length for deviations from the straightness and flatness of the CHILD 01-02-96. The General view of the installation of if-77 is shown in figure 4.

Fig.4 – General view of the installation if-77 NSC "IM"

The maximum permissible error of 0.05 installation interference fringe patterns.

The limit of permissible standard deviation of the random component of the basic error 0.02 of the interference fringe.

The radiation source is a helium-neon optical quantum generator LG-56 (wavelength λ= 0.6328 μm).

A digital camera is used as a reference device.

Measurement result

The results of the measurements measures the flatness in the national standards.

The results of measurements of the flatness measure № 2591 on the standard VNIIMS are given in table 14.

Table 1

Observation number	The readings of the inter-ferometer, Int shares. streaks	The arithmetic mean, int shares. streaks	The arithmetic mean, micrometer	The arithmetic mean, nanometer
1	0,079	0,072	0,023	23,0
2	0,065			
3	0,073			
4	0,068			
5	0,077			
6	0,063			
7	0,075			
8	0,069			
9	0,080			
10	0,071			

Measure flatness deviation

Table 2

Deviation from flatness, nm	Total standard uncertainty, nm	Expanded uncertainty, nm (k=2, P=95 %)
23,0	3,2	6,4

The results of measurements of the flatness measures № 2591 on the standard BelGIM conducted in the direction II (the bands are arranged horizontally) are presented in table 3.

Table 3

Observa-tion number	The readings of the interfero-meter, Int shares. streaks	The arith-metic mean, int shares. streaks	The arithmeti c mean, Micro-meter	The arith-metic mean, nano-meter
1	+0,057	+0,05	**+0,01**	16,2
2	+0,050			
3	+0,050			
4	+0,056			
5	+0,056			
6	+0,050			
7	+0,044			
8	+0,056			
9	+0,044			
10	+0,050			

Table 4

Observation number	The readings of the interferometer, Int shares. streaks	The arithmetic mean, int shares. streaks	The arithmetic mean, micrometer	The arithmetic mean, nanometer
1	+0,062			
2	+0,054			
3	+0,048			
4	+0,048			
5	+0,056			
6	+0,061	+0,05	**+0,01**	17,0
7	+0,048			
8	+0,055			
9	+0,055			
10	+0,049			

Measure flatness deviation

Table 5

Deviation from flatness, nm	Total standard uncertainty, nm	Total standard uncertainty, nm	Expanded uncertainty, nm (k=2, P=95 %)
I-I	+16,2	14,3	28,6
II-II	+17,0	14,3	28,6

The results of measurements of flatness measures № 2591 on the standard NC " IM " conducted in the direction II (the bands are arranged horizontally) are shown in table 6.

Table 6

Observation number	The readings of the interferometer, Int shares. streaks	The arithmetic mean, int shares. streaks	The arithmetic mean, micrometer	The arithmetic mean, nanometer
1	+0,055			
2	+0,049			
3	+0,052			
4	+0,053			
5	+0,054	0,051	**0,0163**	**16,3**
6	+0,052			
7	+0,048			
8	+0,057			
9	+0,047			
10	+0,047			

The results of measurements of flatness measures № 2591 on the standard of NSC " IM " conducted in the direction II-II (strips are arranged vertically) are presented in table 7.

Table 7

Observation number	The readings of the interferometer,	Observation number	The readings of the interferometer,	Observation number
1	0,052			
2	0,048			
3	0,047			
4	0,054			
5	0,058			
6	0,047	0,052	**0,0165**	**16,5**
7	0,057			
8	0,056			
9	0,047			
10	0,056			

Measure flatness deviation

Table 8

Deviation from flatness, nm	Total standard uncertainty, nm	Total standard uncertainty, nm	Expanded uncertainty, nm
I-I	+16,3	14,3	28,6
II-II	+16,5	14,3	28,6

Measurement uncertainty

The total standard uncertainties of the participating laboratories are given in table 9.

Table 9

Input value X_i	Type of uncertainty	VNIIM Standard uncertainty $u(x_i)$, пм	BelGIM Standard uncertainty $u(x_i)$, пм	NSC “IM» Standard uncertainty $u(x_i)$, пм
X_u	A	0,6	0,5	0,5
$\delta_{ИФ}$	B	2,2	9,1	9,1
$\delta_{П}$	B	0,6	6,3	6,3
δ_o	B	2,2	9,1	9,1
u_j		**3,2**	**14,3**	**14,3**

where X_u – the arithmetic mean of the readings of the interferometer, nm;

$\delta_{ИФ}$ - correction due to the deviation of the interferometer readings, nm;

$\delta_{П}$ - correction due to the repeatability of the

readings of the interferometer, nm

δ_o – correction due to operator error, nm;

u_j – the total standard uncertainty of the laboratory with the number j, nm.

The deviations of measurement results from the reference value and the expanded uncertainties of these deviations for the measure of deviation from flatness in figure 5.

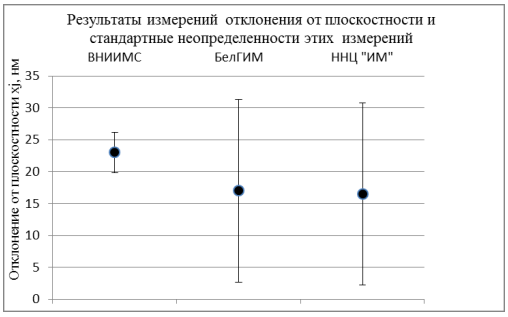

Figure 5 - measurement results of the deviation from the flatness of the comparison standard and the standard uncertainties of these measurements

Conclusion

1. The results of comparisons indicate the correspondence of the measurement uncertainties to the declared values.

2. The standards to be compared are equivalent.

3. The results of comparisons of standard length units in the area of measurements of deviations from the flatness of VNIIMS, BelGIM and NSC "IM" can be considered positive.

Literature

[1] ISO / IEC Guide 98-3: 2008 Measurement uncertainty - Part 3. Guidance on the expression of uncertainty in measurements (GUM: 1995).

[2] COOMET R / GM / 11: 2010 Regulations on comparisons of standards of national metrological institutes of COOMET.

[3] COOMET R / GM / 14: 2006 Guidelines for the assessment of COOMET key comparisons.

Information about the Authors:

V. Lysenko, Russian Research Institute of Metrological Service

V. Kupko, NSC "Institute of Metrology" (Ukraine)

D. A. Novikov, Russian Research Institute of Metrological Service

A. A. Lavrukhin, Russian Research Institute of Metrological Service
e-mail: lysenko@vniims.ru

E. Isgandarzada, Azerbaijan Technical University

A. Shukufa, Azerbaijan Technical University