A system of providing uniformity of measurement for color characteristics in accordance with the state verification scheme (GOST 8.205–90) is considered. Results are provided for studying the metrological characteristics of a contemporary class of spectrocolorimeters from the firms GretagMacbeth and X-Rite (USA).

**Key words:** color and chromaticity coordinates, colorimetric system, light source for measuring color, whiteness, luster.

The study of color, i.e., color science, embraces very different problems in many related subjects. Color measurement is a precise science since it is concerned with the technical side of color, i.e., a vector quantity in three-dimensional space.

Color measurements are one of the largest fields of optophysical measurements and they are distinguished by introduction into many fields. The quality of production of more than twenty branches of industry is mainly determined with respect to color.

Use of color measurements in branches of industry may be characterized as:

- **light, food, and paint industries** – determination of product quality; cloth and non-cloth materials, background material for safety clothing, artificial and natural leather, footwear raw material, food products, food raw material, conserves and semifabricated products, lacquers, paints, pigments, light-reflecting films, petrochemical products;
- **paper industry** – determination of the color characteristics of paper, carton, parchment, and also whiteners for these materials;
- **electrical engineering, electronic, and telecommunication industries** – monitoring the color characteristics of color sources for external and internal illumination, medical lighting fixtures, color kinescopes, monitors, panel lights, light indicators, etc.;
- **agro-industrial complex** – monitoring the quality of agricultural raw materials, products, feeds, flour.

Color measurements should be carried out under identical starting conditions or else their results are not comparable.

The results of color measurements are affected by three conditions:

- a standard colorimetric observer;
- a source of illumination;
- illumination geometry (observer).

Currently the International Commission for Illumination (ICE) controls the measurement of color characteristics for two “standard colorimetric observers”: observer ICE 1931 with a field of view of 2°, that corresponds to the yellow spot of
an eye shell, and observer ICE 1964 with a field of view of 10° that is considered more appropriate for carrying out studies with respect to equating colors. Standardization of the illumination source is required since color perception clearly does not depend on the spectral composition of the radiation generating it.

Without maintaining illumination conditions (observation), it is impossible to achieve uniform color measurements. Classical geometries for measuring color characteristics are 45/0, 0/45, D/0, 0/D. However, currently in the paint textile, polygraphic and some other branches of industry there are also materials whose measurement of color characteristics with standard illumination geometry is not informative.

Provision of uniformity for measurement of color characteristics is accomplished in conformity with the state verification scheme according to [1], at the head of which is the state special standard of color and chromaticity coordinates GÉT 81–90. Within this standard, there are transparent and reflecting sets of units of measurement coordinates for color and chromaticity that store and transfer their dimensions to the secondary standard VÉT 81-90–2003. From the secondary standard, the dimensions of units are transferred by means of transparent and reflecting sets of measurements to standard measurement provisions. The standard measurement provisions are highly accurate devices for measuring color and chromaticity coordinates, and a set of transparent and reflecting measures for transfer of the units of measurement to the operating measurement provisions.

Transfer of the dimensions of units from the highest to the lowest level of the verification scheme is accomplished either by comparison using a comparator or by direct measurements. Errors for measurements of color and chromaticity coordinates are standardized for all levels of the verification scheme.

A disadvantage of the existing verification scheme is the fact that there are no units such as whiteness, luster and optical density for the needs of the polygraphic industry, whose measurement is directly connected with measuring color characteristics, and also nonstandard illumination (observation) geometry making it possible to carry out measurements for a new generation of materials. Therefore, it was decided to consider the standard [1] taking account of contemporary requirements for measuring the coordinates of color, and chromaticity, and quantities connected with them considering estimates of errors for all levels of the verification scheme in accordance with new requirements [2].

Another disadvantage of the existing verification scheme is a lack of a class of instruments such as color comparators that are used quite often in different branches of industry in order to monitor production processes, and also color control specimens that are necessary for checking the correctness of color and chromaticity coordinates by working instruments.

The existing verification scheme for measurement provisions provides uniformity for measurements of color and chromaticity coordinates, and whiteness and luster, since there is a local verification scheme for measuring the whiteness index at the head of the secondary standard for units of color and chromaticity coordinates, and there is a local verification scheme for measuring units of luster at the head of the high accuracy facility for units of luster.

Rapid development of the modern generation of spectrocolorimeters and their relative low cost makes it possible for many establishments to equip their laboratories with new equipment. It is very important that the instruments of different firms, manufactured by fundamentally different schemes, measure color characteristics indicated in the standard documents with a high degree of reproducibility and repeatability.

In order to provide transfer of the dimensions of units and reproducibility and repeatability of measurements in the field of colorimetry, VNIIOFI carries out work in studying the metrological characteristics of a new generation of colorimetric instruments used in different branches of industry. This is the metrological provision of NIIgoznak and various metallurgical plants supplying production for export. In addition, currently colorimetric measurements occupy an increasing place in clinical diagnostics, and the pharmaceutical and food industries.

In the last two years, the Institute has carried out research into the metrological characteristics of contemporary imported instruments, i.e., spectrocolorimeters from the firms GretagMacbeth (USA) and X-Rite (USA).

Spectrocolorimeters from the firm GretagMacbeth are spectral instruments based on a double-beam optical scheme with an integrating light sphere and a xenon flash-lamp as a source of illumination. Use of a comparison beam in the spectrocolorimeter increases measured result stability. Any deviation in the electronic system, ageing of the coating of the inte-

1 The designation is retained in accordance with the existing verification scheme.