The development of the standards of the EPR-spectrum using the quartz monocrystal the morion

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Abstract. The results of the development of the standard of the EPR-spectrum are represented. This standard is used for determination of EPR-spectrometer resolution. This standard can be used as a work standard, providing traceability to the State primary standard.

The Electronic Paramagnetic Resonance (EPR) is a phenomenon of resonance absorption of electromagnetic energy in the centimeter or millimeter wavelength range of the paramagnetic substances placed in a constant magnetic field.

The EPR is used in a research of the paramagnetic centers and their environment in material. EPR-spectrometers allow to determine the concentration and identify paramagnetic particles in any aggregate state [1, 2].

Evaluation of sensitivity and resolution of EPR-spectrometers is possible with using the standards of the number of paramagnetic centers and EPR spectrum standard (ESS).

Traditionally, a perylene solution in sulphuric acid is used to determine the resolution of EPR-spectrometers. However, the capillary with solution of perylene is extremely sensitive to influences of external factors of the environment and is unstable over time. As a result its EPR-signal level decreases irreversible to zero. Thus its application for measuring of ESS is possible only for short time periods [3].

Minerals (natural crystals) can be a good alternative for organic solutions with insufficient resistance to environmental conditions. They have narrow and stable EPR lines. The monocrystal of natural quartz the Morion seems to be the most promising [4, 5].

It was found that the EPR-spectrum of the Morion quartz crystal samples is anisotropic. It has strong dependence on the orientation of the crystal in magnetic field of the EPR-spectrometer.

The narrow lines periodically appear in the EPR spectrum while rotating the quartz Morion sample with random orientation around a rotation axis. Their width is less than 6 mkT, characterizing super-thin structure. However, it is extremely difficult to reproduce the results even at the same sample.

We have an idea how to receive the identical samples from a quartz crystal the Morion with the EPR-spectrum containing necessary narrow lines. The idea was to create crystals with known axis orientation.

The orientation of the quartz the Morion crystal was performed with X-ray goniometer 1H-1C.
Measuring samples were located in the resonator and EPR-spectra at various rotational angles of crystal axes were recorded. These research showed the reproducible dependence of the EPR-spectrum of quartz from sample to sample from orientation of axes in magnetic field of the EPR-resonator. It was found that when aligning crystal axes to the direction of magnetic field in the resonator superposition of many lines of the EPR-spectrum (the so-called not resolved thin structure) was observed. The EPR-spectrum example with the coincidence of the magnetic field direction with Z crystal axis presented in figure 1.

![Figure 1](image1.png)

**Figure 1.** A quartz EPR-spectrum with the coincidence of the magnetic field direction with Z crystal axis.

![Figure 2](image2.png)

**Figure 2.** Emergence of the narrow line in a quartz EPR-range the Morion at a deviation of the direction of axis Z of a crystal from the direction of magnetic field in the resonator.

Similar spectra are received on all oriented samples. It was also found that with turn axes of the crystal at a small angle (less than one degree), the hyperfine structure of a EPR-spectrum appears (figure 2).

The line width of hyperfine structure of the EPR-spectrum is less than 6 mkT and steadily reproduced from measurement to measurement. For ESS samples based on the quartz the Morion it was established that the line width of hyperfine structure of EPR-spectrum is 4-6 mkT. That is fully compliant with the requirements for measuring the ESS standards.

Thus, the standard of ESS has been developed. It reproduces EPR-spectrum and uses the quartz the Morion with the known values of linewidth of EPR-spectrum and the hyperfine structure component of the EPR-spectrum. This standard can be used for resolution determination and calibration of values of magnetic field of EPR-spectrometers.

References.

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