Goniometric study of crystals

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Goal

Describe basic methods of goniometric study

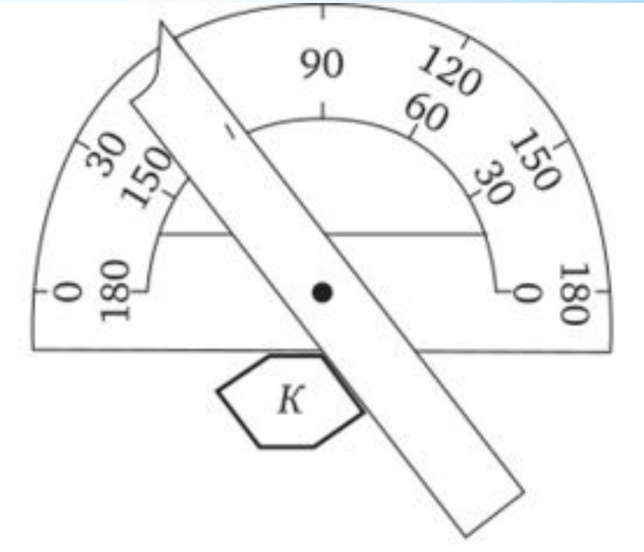
Objectives

1. Studying method of external crystals morphology
2. Goniometry
3. Constancy angles law

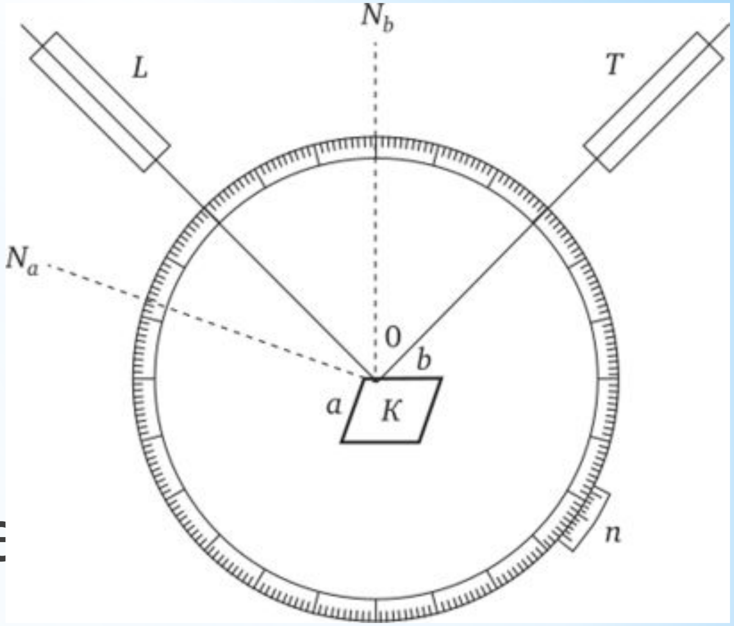
Studying method of external crystals morphology

Crystal cut is an important characteristic that often makes it possible to diagnose a substance without resorting to additional analysis types. First studying method of external crystals morphology was goniometry method, based on constant angles law between corresponding faces. According to this law, regardless of the same substance crystals variety , angles between corresponding edges remain constant. For measurement using applied and reflective goniometers. Despite fact that this type’s first device was designed in the XVIII century, such studies conduct in our time is very relevant, in particular, to establish relationship between conditions for obtaining crystals and their external form.

Sufficiently large samples (more than 0.5 cm) with uneven and matte edges are measured using applied goniometers. Simplest application goniometer is a protractor with a movable ruler. The crystal is fixed in such a way that a pair of faces between which the angle is measured tightly clamped between protractor's lower bar and ruler. Double scale on the protractor allows determining with sufficiently low accuracy (about 0.5 °) both the angles between the normals to the faces, counting readings from left to right, and true intergeneral angles, moving along scale from right to left.

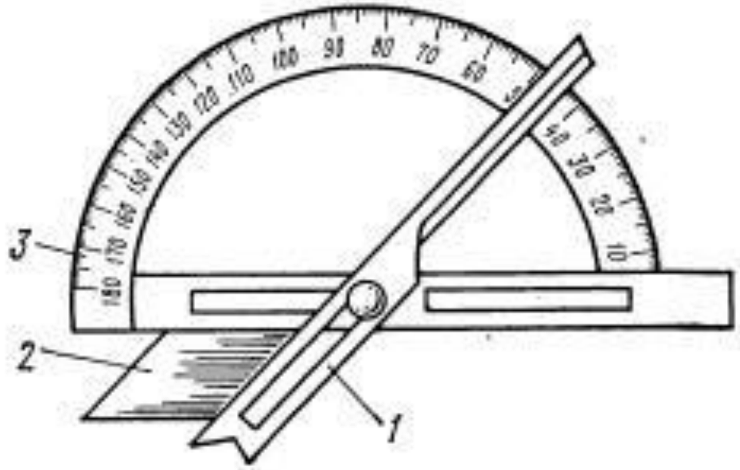


For more accurate measurements (from a few seconds to 1 min) and work with small crystals with shiny edges, reflective goniometers (single and double circles) have been developed, using good reflectivity of high-quality crystal surfaces and geometric principles of incident propagation and reflected light rays.



Goniometry

Crystallography dealing section with angles measurement is called goniometry (from the Greek word “gony” - angle). A device for measuring angles between crystal faces is called a goniometer. There are two types of goniometers — applied and reflective. An applied goniometer (Fig. 3) was proposed by Karanjo in 1780. Measuring angles accuracy is 0.5 °. An applied goniometer is usually used to measure crystals with face sizes greater than 0.5 cm.. Reflective goniometers are used to study small crystals with shiny edges and for more accurate measurements.



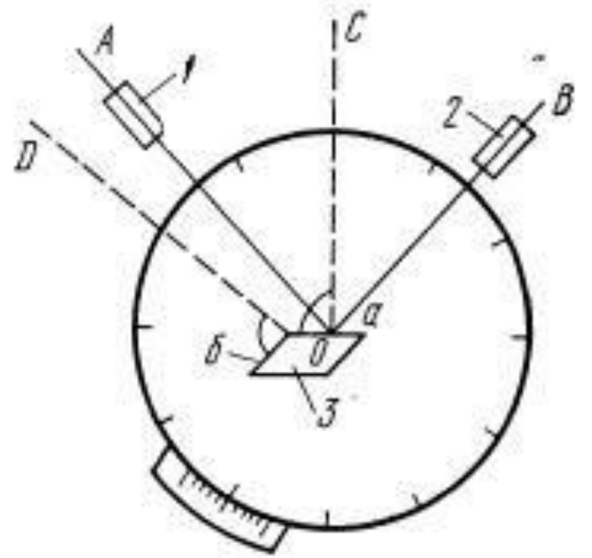


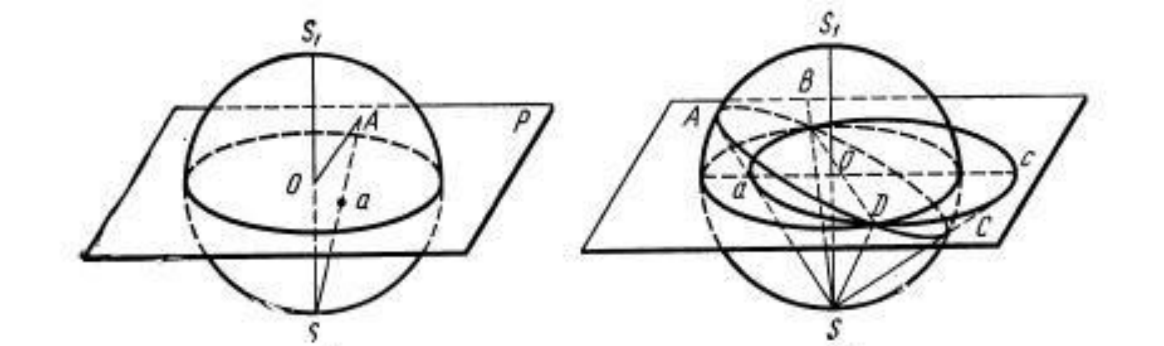
Figure 3. Applied goniometer: 1- rotating ruler, 2 - measured crystal, 3 - protractor

Figure 4. Diagram of the reflective goniometer:
1 - collimator, 2 - telescope, 3 - crystal

Reflective goniometer works as following scheme (Fig. 4). A narrow beam of rays is passed through the collimator 1, equipped with a narrow slit and a collecting lens, and falls on a crystal’s face (3). Reflected from it, the rays beam hits the telescope (2). The reflection of the light beam (“signal”) in the telescope can be obtained only in the case where the angles of AOC and COB are equal. By fixing the collimator position and optic tubes, we rotate the crystal around the axis O until the face b takes the position b of face a, and by fixing the values between the first and second circle positions on the axis of which the crystal is fixed, we can determine the angle between normals C and D to edges a and b.

Reflective goniometers allow measuring angles with an accuracy of 1 or 30.

To study the geometric crystals shapes used stereographic projections. To construct a stereographic projection of a crystal from its center O, mentally arbitrary radii describe a ball, called a ball of projections. Then the diametrical plane P of this ball (the projection plane) and the diameter SS1 (axis of the projections) perpendicular to it are carried out. Point S is called point of view.



To get a stereographic projection of any direction OA, its output on the ball is connected with a straight line S point. The trace of SA sight line on projections plane, that is point will be the stereographic projection of this direction OA (Fig.5, a). To obtain a plane stereographic projection (for example, ABCD), it is transferred parallel to itself in the projections center and continued until it intersects with the projection ball surface. As a result of the intersection, a large circle arc ABCD is obtained on a ball, all points of which are connected by straight lines with a view point and receive a projecting cone. The resulting curve ABCD, in which the projecting cone intersects with the projection plane, is the stereographic projection of this plane ABCD (Fig.5, b). Thus, the planes stereographic projections are represented by circular arcs and the directions projections are shown by dots.

Constancy angles law

A single crystalline substance's different forms are subject to the same crystal structure. And since the external form of given substance crystals is determined by its internal structure, there must be a definite regularity between the crystals cut elements of this substance various forms. This pattern is expressed in the constancy angles law .

The law says: *The dihedral angles between the respective crystal faces of the same substance at constant temperature and pressure are constant.*

Relatively identical conditions reservation is necessary, since different pressures and temperatures, varying the interatomic distances in different directions, cause angular values oscillations. In practice, these oscillations are insignificant and can be disregarded. This is true only for crystals with the same structure. In connection with changes in physicochemical conditions, radical reorganizations of the structure itself can occur, as a result of which, for example, a diamond is transformed into graphite (or vice versa). It goes without saying that the law of constancy angles applies only to crystals belonging to the same polymorphic modification. From this law it follows that in most cases, by measuring angles, it is possible to prove that the investigated crystal belongs to a specific substance.

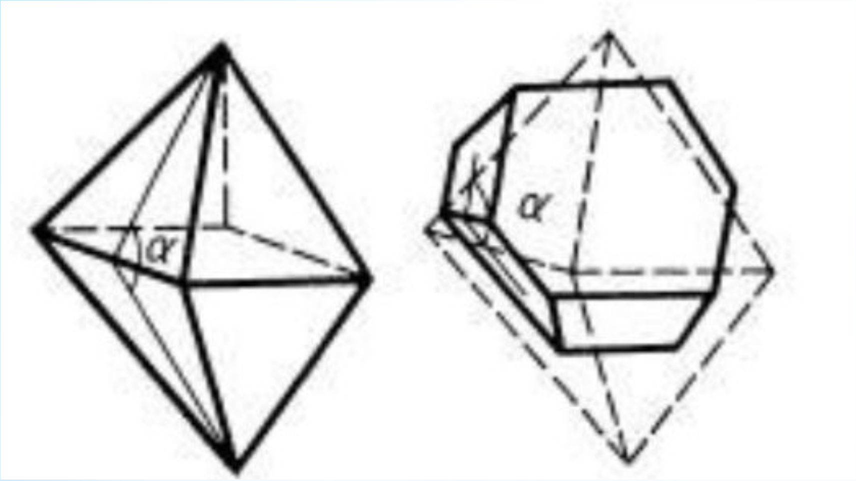


Figure shows diamond crystals of a regular and distorted shape, the octahedral faces of which form the same angle

a = (109 ° 28 ').

The constancy of the angles between the faces of diamond crystals (crystals of regular and distorted shapes)

Conclusion

Method of external crystals morphology was goniometry method, based on constant angles law between corresponding faces. According to this law, regardless of the same substance crystals variety , angles between corresponding edges remain constant. For measurement using applied and reflective goniometers.

VOCABULARY

* external– [ikˈstərnl] - внешний - сыртқы
* measure– [ˈmeZHər] - измерения - өлшем
* dihedral–[dīˈhēdrəl] - двугранный- екіқырлы
* beam– [bēm] - луч - сәуле

Thanks for your attention!