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SIMPLE METHOD OF OBSERVING AXIAL AND INTERPLANAR CHANNELING

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The use of radioactive sources for the observation of investigation of orientational effects is made difficult by the small dimensions of the channels and by the impossibility of obtaining a sufficiently intense particle flux along the close-packed directions in crystals. Usually one studies the anisotropy of emission of various particles from single crystals [1], or use is made of the so-called "canalography" method [2]. In most cases, however, accelerators are used.

We consider here a simple method, using a pointlike radioactive source, which makes it possible to observe the pictures of interplanar and axial channeling and to study some of its characteristics. The experimental setup is shown in Fig. 1a.

Source 1 is a platinum wire of 0.5 mm diameter, the end of which is molten in the form of a sphere of 0.8 mm diameter. Po^{210} is electrolytically deposited on the forward half of the sphere. The total activity of the source is about 1 μCi, and the specific activity is ∿200 $\mu Ci/cm^2$. Diaphragms 2 have diameters from 0.2 to 0.8 mm are placed in front of the source. The investigated objects were single-crystals of silicon 25 - 35 μ thick (the films were prepared by I. R. Baidzhanov, to whom the authors are grateful).

The detector was an ordinary photographic plate. The distance between the source and the Si film, and also between the Si and the photographic plate, could be smoothly varied and measured with accuracy to 0.1 mm. The cassette with the source, film, and plate was placed in a vacuum chamber.

The principle is clear from Fig. 1b. Let us assume that the directions of the close-packed axes of the single-crystal film 3 coincide with the directions of the hatches in the figure. Alpha particles are emitted from point A in all directions. The bulk of them is either fully absorbed in the silicon plate, or loses an appreciable energy in it and darkens slightly the photographic plates (trajectories AD and AE). The α-particles that fall in the channels lose less energy and produce an appreciable density, so that a system of lines and spots are produced on the plate,

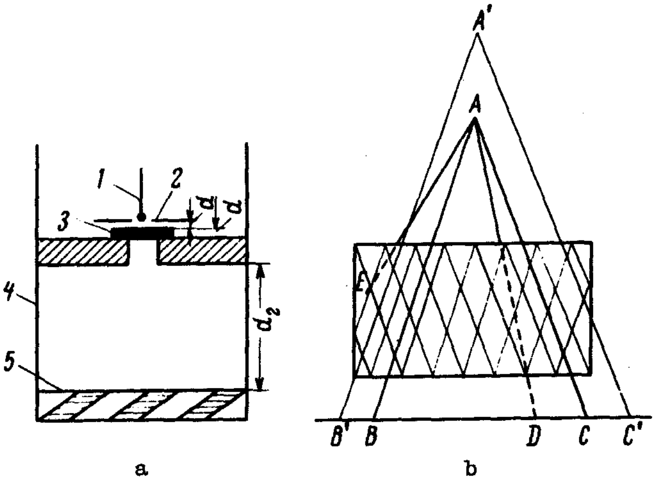

Fig. 1. Diagram of method: 1 - source, 2 - diaphragm, 3 - crystal, 4 - light-tight chamber, 5 - photographic plate.

corresponding to the positions of the principal axes and planes in the crystal.

The exposure time depends on the source activity, the foil thickness, and the distance between the source and the photographic plate. It ranged from 14 to 36 hours in our experiment.

The results of the experiments are shown in Figs. 2a and 2b. It is seen from the character of the arrangement of the lines on the photograph that the surface of the Si plate is parallel to the (111) plane. Lines corresponding to the planes (100) are clearly seen - they form a large equilateral triangle; the (110) lines intersect at the center, and the (111) lines form a small triangle.

The obtained picture must be distinguished from the so-called star pictures investigated in [3], where a well-collimated particle beam was directed exactly along the axial channel and was pushed out into the interplanar channels by interaction with the rows. In our experiment, on the other hand, the particles strike the crystal from the very beginning from all possible directions, and enter the interplanar channels at different angles to the principal axes. Such a picture is somewhat similar to that obtained by Tulinov's method [4, 5], but in his case the photographs show tracks of rows and planes, whereas in our case we see so to speak, "inter-row" tracks.

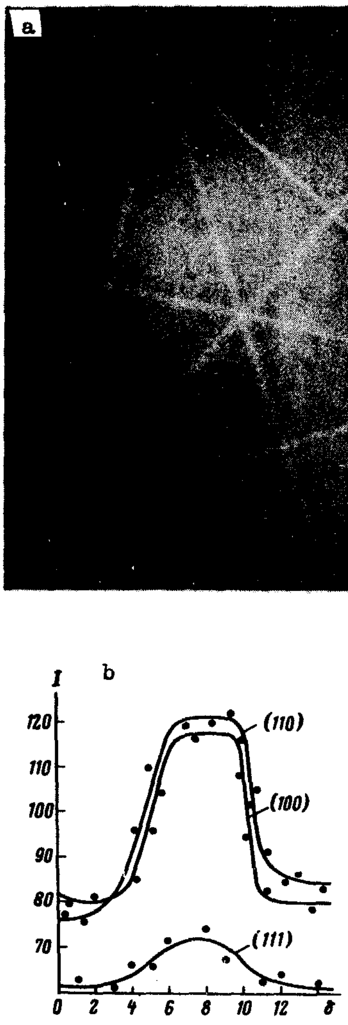

Fig. 2

The described method can find practical applications in some cases. In particular, it makes it possible to determine relatively simply if a given film is a single crystal or consists of several blocks. In the presence of blocks, breaks should be observed on the photograph, which, following [2], can be called a canalogram. This method can also be used to determine the orientation and to orient single-crystal films 1 - 10μ thick. In order for the canalogram to be sufficiently sharp, the crystal thickness must be of the order of the free path of the non-channeling particles. If the crystal thickness is much smaller than the free path, it is necessary to decrease the energy of the incident particles by placing a foil of appropriate thickness between the source and the diaphragm. The main shortcoming of the method is the very long exposure. Sometimes this shortcoming is offset, however, by the fact that there is no need for an accelerator or an electronograph.

By varying the distance between the source and the plate of the crystal, or by moving the source along the surface of the crystal, it is possible to investigate various sections of the film (Fig. 1b, source position A', trajectories A'B' and A'C'). In the presence of a smaller source it is possible to determine the orientation of the individual blocks in the plate (and in general to investigate very small sections of the crystal).

Figure 2b shows the results of photometry of the canalogram in different directions. They reduce to the following: 1. The intensities of the lines corresponding with different packing densities are different. The most intense lines are produced by the (110) planes, and the least distinct (from among those seen on the photograph), by the (111) planes. 2. The angular line width, on the one hand, characterizes the angle of emission of the channelled particles from the crystal, and consequently depends on the channel parameters and on the energies of the emitted particles, and on the other hand it depends on the dimensions of the source and on the distance to the photographic plate. Since this distance cannot be made sufficiently large (owing to the increased exposure), it follows that when a source of 0.5 mm diameter source is used the line width is determined mainly by this last factor. 3. The line profile has a complicated form that is far from Gaussian and is determined also by two factors, the angular distribution of the particles in the channels and the inhomogeneity of the active layer of the source.

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INFLUENCE OF MAGNETIC FIELD ON THE BEHAVIOR OF THE SUSCEPTIBILITY IN THE REGION OF A FERROMAGNETIC PHASE TRANSITION

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The magnetic susceptibility is one of the main characteristics of the dynamic state of a spin system. Phase transitions are usually characterized by the appearance of singularities in the temperature dependence of the susceptibility. The most interesting is the temperature region immediately adjacent to the Curie point, for this is precisely where the greatest development of fluctuations is observed and where long-range order appears.

The experimentally determined character of the dependence of the susceptibility χ on the distance to the the Curie point depends strongly on the choice of the Curie temperature T_C itself. Most existing well-developed methods of determining T_C are extrapolation methods [1]. They are based on various assumptions concerning the equation of state of the ferromagnet near T_C. The determination of T_C from direct measurements of the singularities of the behavior of the macroscopic parameters is likewise insufficiently accurate and unambiguous. As shown in our earlier paper [2], a very accurate method of determining T_C can be the measurement of the depolarization of the neutrons passing through the investigated sample. In this case T_C is determined from the position of the maximum of the derivative of the polarization of the passing neutrons with respect to the temperature. To determine the functional dependence of the susceptibility on the temperature, it is important to determine independently and experiment-