SOME ASPECTS OF SURFACE PROCESSES ON A SOLID BODY

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ANNOTATION

At the article outlines the main regularities of surface phenomena; the doctrine of surface forces and adsorption, stability, surface energies of stabilization and relaxation of the surface and its reconstruction. Considered physical is the equilibrium of macromolecular compounds.

Keywords: surface energy, relaxation, interface, vacuum, stability , crystal, theoretical and real strength, lattice, valence bonds, evaporation.

The idea of bodies without boundaries has proved to be extremely fruitful in the study of the bulk properties of condensed matter. The theory of a rigid body, built for a model in which the body is considered to be infinitely extended or cyclic boundary conditions are artificially set on its boundaries, turning it into an endless repetition of the same fragment, acquires completeness and simplicity. The retribution for these simplifications is the complexity, and sometimes even the impossibility, of describing those phenomena in which the interfaces between bodies of different nature are significant. At the same time, all real bodies are limited, and surface phenomena play an important role, both in natural and technological processes. The modern development of technology towards the miniaturization of all devices and the increasing role of nanotechnologies makes the understanding of processes on the surface especially relevant.

The first step towards the description of spatially limited bodies is the idea of an infinitely extended flat interface between two phases: a solid body and vacuum. Of course, such a state is not equilibrium from the thermodynamic point of view, since evaporation must occur. However, provided that the equilibrium vapor pressure is low, this process is slow and we will not deal

with it for now. Then, for a crystalline solid, two phenomena associated with the presence of a surface come to the fore: relaxation of the surface and its reconstruction.

Surface relaxation is understood as the difference between the distances between the last crystallographic planes parallel to the boundary plane with vacuum and the distances between the same planes in the bulk. It is assumed that the arrangement of atoms in the last plane completely coincides with the arrangement of atoms in all other planes parallel to it. Otherwise, if the atoms of the last plane are displaced from the positions they occupy in other planes located in the bulk of the material, then we say that the surface has been reconstructed.

One of the common causes of surface reconstruction is the appearance of "dangling bonds" on it. Thus, silicon forms crystals in which all atoms are bonded to their four nearest neighbors by valence bonds. Silicon atoms located on the surface are devoid of neighbors, which should be located in the overlying layers. The valence bonds that turned out to be free lead to a stronger interaction between atoms located in neighboring rows of the surface plane. As a result, surface atoms are divided into pairs, and the distance between atoms in a pair is less than the distance between atoms belonging to neighboring pairs. Thus, surface reconstruction can lead not only to a significant displacement of surface atoms, but also to an increase (in this case, to a doubling) of the repetition period of similar elements compared to the bulk lattice period. In some cases, there is also a change in the symmetry of the arrangement of atoms in comparison with what took place in the bulk.

Stable condensed bodies do not spontaneously fall apart. From a physical point of view, the reason for stability is the need to do work to form new interfaces with vacuum when the body is divided into parts. Thus, the energy of a body that has a longer boundary with vacuum is greater than that of a body that has a less extended boundary. This additional energy is related to the surface area of the body and is called surface energy.

In equilibrium, the body must take such a shape in which the surface energy is minimal. For liquids, this requirement is reduced to the minimum surface area for a given body volume. As is known from mathematics, the ball has the smallest surface for a given volume, therefore, any finite volume of liquid in a free state must take the form of a ball.

Solid crystalline bodies have a more complex equilibrium shape, since the surface energies of different crystallographic faces are not the same. In this case, the minimum surface energy is achieved not with a minimum total surface area, but with a shape that provides a large proportion for those crystallographic faces that have a lower surface energy. If the dependence of the surface energy on the direction in the crystal is known, then the equilibrium shape of the crystal can be obtained using the Wulff construction. From an arbitrary point taken as the center of the crystal, segments are plotted in all directions, proportional to the surface energy of those planes that are perpendicular to this direction. Then, the inner envelope surface of all such planes is constructed, drawn through the ends of the corresponding segments. If one of the crystal faces has a surface energy much lower than the other faces, then almost the entire crystal surface (with the exception of small roundings near the edges) will be formed by just such faces. A good example is cubic salt crystals, in which all six faces are formed by planes that have the same structure and have the lowest surface energy. The shape of real crystals does not always coincide with the body obtained by the method described above, since the growth of crystals often occurs under conditions very far from equilibrium. In this case, the

crystal shape is affected not only by the magnitude of the surface energy of one facet or another, but also by the rate of delivery of growth material to it.

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