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Nobel Prize in Chemistry 1932

Irving Langmuir

The Nobel Prize in Chemistry 1932 was awarded to Irving Langmuir *"for his discoveries and investigations in surface chemistry"*.

RESEARCH INFORMATION:

Superficiality is a quality which has always had a bad reputation, not least within the field of science and among scientific practitioners. In these circumstances it may possibly arouse some surprise that, in awarding this year's Nobel Prize for Chemistry, the choice of the Royal Academy of Sciences has fallen on a work on surface chemistry. But here, as often in other cases, it is necessary not to let words obtain too great a power over thought. If one frees oneself of this power and investigates the matter more closely, it will be found, on the contrary, that in reality surface chemistry has contributed greatly to the deepening of our knowledge of matter in its most minute particles.

Surface chemistry as the designation of a special discipline within physical chemistry is a comparatively new conception. The phenomena with which it is concerned are none the less well-known since of old.

One of these phenomena is that of adsorption. The power of certain solid bodies to retain or, as we say, to condense gases on their surface has long been known and made use of for all manner of practical purposes. But it has not been known how this adsorption really takes place - and opinions have been divided as to what forces operate thereby. As a rule the conception will probably have been that the gas nearest to the adsorbing solid body, thus in the boundary surface between the solid and the gaseous condition itself, appears in a more or less condensed state, and that the density decreases continuously outwards in proportion as the solid surface is left, in about the same way as the density of the atmosphere of the earth decreases upwards in proportion as we move away from the solid crust of the earth. This year's Nobel Prize winner in Chemistry has advanced an entirely confticting theory and one which at first sight seems to be particularly bold.

According to this theory the layer of gas adsorbed is limited - in ideal border-line cases at least - to an extremely thin film of gas molecules extending over a single plane, thus a film whose thickness is that of a single molecule or, in other words, is monomolecular. And the force which retains the gas particles is derived from the chemical field of forces of the surface atoms, in that the atoms on the boundary surface are conceived as partially unsaturated and, in virtue of their so-called residual valences directed outwards, equipped with the power to bind a corresponding number of atoms in the gaseous body. And since these residual valences - in any case in crystalline bodies - must be conceived to make their effects felt at fixed points and at fixed distances from each other, it follows immediately that the adsorbed gas particles also will lie at fixed distances from each other and at fixed points. One can visualize it most easily if one thinks of the adsorbing solid surface as a chess-board, where each square can only be occupied by a single gas particle. When all the squares are occupied adsorption ceases.

Now it may be asked: Is there any real basis for such an assumption? Can one really adduce in proof anything which seems so to escape direct observation? With the view of answering these questions I will venture to borrow an example from an account sent in to the Academy of the work which has been awarded the prize.

Assume that hydrogen gas is exposed at very low pressure in an electric bulb to the influence of the hot metal filament. The hydrogen gas molecules are broken up, dissociated into atoms, and these are strongly adsorbed by the glass surface of the wall of the lamp, if the latter is kept well-cooled with liquid air. One finds then that a maximum quantity of hydrogen is taken up by the glass surface, or by a certain part of it, let us say one square centimetre. On the other hand, the size of the hydrogen atoms is known, and so the number of atoms which ought to find room on the same surface unit can be calculated. It is then shown that the quantity of hydrogen gas thus calculated is in satisfactory agreement with that previously found. The layer of hydrogen gas is thus, approximately at least, only of the thickness of one layer of atoms.

Another experimenter has allowed a known surface of metallic gold to adsorb air during the transition from a very high vacuum to ordinary atmospheric pressure. With the help of an extremely sensitive micro-balance he has been able to make a direct determination of the amount of air thus retained by the gold and found that it corresponds to a layer of oxygen and nitrogen molecules of only the thickness of one molecule.

Quite new methods of determination, based on the use of electron bombardments and the determinations of electron interferences, have finally indicated that when, for example, hydrogen is adsorbed on the surface of a nickel crystal, a regular pattern is formed, where the distance between the atoms of hydrogen is twice as great as the distance between the atoms of nickel. Thus, a pretty confirmation of the conception of the adsorbing surface as a chess-board, where the adsorbing particles are retained in definite positions.

The work which has been awarded the prize does not, however, comprise only investigations concerning the adsorption in the boundary surface between gases and solid bodies, but also investigations concerning the thin films in the boundary surface between gases and liquids and concerning the adsorption on the surfaces of liquids. The well-known phenomenon of the spreading of an oil film has served as a starting-point for these investigations and the determination of the lateral pressure with which such a film opposes attempts to diminish its surface.

It has been found *inter alia* that there are such films where the molecules can move around each other freely, something like the molecules in a gas, but with the difference that

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here they only move in two dimensions, while in an ordinary gas they move in three. This has opened a new and important field for investigations in chemistry: the study of the conditions of matter in the two-dimensional world, and has in addition afforded valuable information, not only as to the structure of molecules, but also as to the forces working within and between them.

In the rules of the Nobel Foundation we read: "No work shall have a prize awarded to it, unless it has been proved by the test of experience or by the examination of experts to possess the pre-eminent excellence that is manifestly signified by the terms of the will."

In this respect, if at first there could have been any uncertainty as regards the work now awarded the prize, this uncertainty has been ever increasingly dispelled in the light of the researches of the last few years, to be succeeded by an increasing insight into the fact that the work breaks entirely new ground and that considerable parts of it are of lasting value.

This value appears in a still clearer light if we reflect that a multitude of chemical reactions of the utmost importance both technically and biologically, not to mention physiologically, are precisely surface reactions and consequently cannot be fully comprehended or mastered without an intimate knowledge of the nature of the elementary surface processes.

Numerous scientists are at the present time working industriously and successfully in this field of research. It would seem, however, that greater honour is due to the first man, the pioneer, who has broken new ground, than to the cultivators of ground already cleared, however industrious they may be.

Influenced by these considerations the Royal Academy of Sciences has decided to award this year's Nobel Prize for Chemistry to Dr. Irving Langmuir of Schenectady "for his outstanding discoveries and investigations within the field of surface chemistry".

The Royal Swedish Academy of Sciences is sure that it is acting in accordance with the views of the scientific world in awarding to you this year's Nobel Prize for Chemistry for your most important discoveries and researches in the field of surface chemistry.

In proffering to you the sincere congratulations of our Academy, I have the honour of asking you to receive this prize from the hands of His Majesty the King, who has been graciously pleased to undertake to present it to you.

For more details please visit:

http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1932/press.html