Green.—There are four distinct greens:—

1. *Grass Green.*—Which is obtained by the oxide of chrome, or a mixture of glass of antimony and oxide of cobalt.

2. *Bottle Green.*—Prepared with protoxide of iron.

3. *Ancient Emerald Green.*—Prepared with oxide of copper mixed with a small quantity of finery cinders.

4. *Modern Emerald Green.*—This color, which is far more beautiful than the preceding, is prepared with a mixture of oxides of nickel and uranium.

Black.—Is prepared with peroxide of manganese, oxide of copper, oxide of cobalt, in equal parts; or else with a mixture of finery cinders, peroxide of iron, oxide of copper, or cobalt.

Hyacinth.—The hyacinthine color is obtained with a large quantity of red oxide of iron, and the oxide of nickel.

To be Continued.

On the Chemical Reactions produced by bodies which intervene only by contact. By E. MITSCHERLICH, (Ann. de Ch.)

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Whatever length of time hydrogen and oxygen gases may be left in a state of mixture with each other, they never combine, even in the presence of such bodies as sulphuric acid, potash, or lime, which have a great affinity for water, and which, it would seem, ought to provoke its formation. If, however, metallic platina be immersed in a mixture of these gases, their combination is instantly produced on the surface of the metal.

We may mix these gases in the proportions which constitute water, and in a very short time the hydrogen and oxygen are so distinctly diffused, that each molecule of the one finds itself in presence of a molecule of the other; and since the molecules of gaseous bodies possess an excessive mobility, and as their cohesion is not an obstacle to their combination, as in the case of solid and liquid bodies; and since also we may suppose that the affinity of hydrogen and oxygen in water is equivalent to a pressure of many thousand atmospheres, it must be at once admitted that besides the ordinary forces (raisons) which oppose chemical combination, there is another which prevents the combination of hydrogen and oxygen by neutralizing their natural affinity.

Some bodies in a state of solution act among themselves in the same manner as hydrogen and oxygen, with regard to platina. We may abandon, for a long time, an aqueous solution of cane sugar without perceiving any alteration in it; but if we add to it dilute sulphuric acid, the sugar, without combining with the sulphuric acid, solidifies a portion of water, and is transformed into glucose. The decomposition of gaseous ammonia by incandescent copper, is one of the (not very numerous) examples in which the decomposition of a gaseous body is promoted by a solid body: we have, on the contrary,

numerous examples of decompositions of this kind among liquid and solid bodies, which undergo themselves no change during the reaction;—the decomposition, for example, of the binoxide of hydrogen under the influence of various bodies,—the decomposition of chlorate of potash by the oxide of copper, and other fixed bases.

Before we undertake to ascertain why certain chemical reactions take place under the influence of bodies which interfere with each other only by their presence, we must seek to give an account of the manner with which bodies that do not combine chemically, act upon each other when placed in immediate contact.

We may show with the greatest facility the attraction which a solid exerts upon a gaseous body, by employing the first in a condition in which it presents the greatest possible surface under the smallest volume, as in very thin leaves, or better, in impalpable powder. Charcoal, and many substances of difficult fusibility, like platina, which may be obtained in a state of extreme tenuity, are very suitable for these experiments.

I have calculated, in the first volume of my *Traité de Chimie*, the amount of surface in one cubic inch, divided into little cubes of $\frac{1}{2400}$ of an inch on each side, by two series of perpendicular sections. It would be equal to 100 square feet, without estimating the extent of the interstices.

If any substance be brought to such a state of tenuity that we may suppose it reduced to its atom, or, at least, to a degree of known approximation, we may then calculate the surface which it would represent.

The estimate may furnish the value of the greatest diameter of an atom of a chemical compound, when the latter is obtainable in the condition of thin plates, or of vesicules, by the colors which they present;—thus the diameter of an atom of water must be, at most, $\frac{1}{1000000}$ of an inch, according to the color which appears at the thinnest portion of a soap bubble.

In reducing a dilute solution of chloride of platina, by means of carbonate of soda, and formic or tartaric acid;—or in decomposing very dilute sulphate of platina by weak alcohol, the metallic platina obtained in either case must be in the state of molecules, since the molecules, at the moment of reduction, are separated by water, which necessarily prevents their agglomeration.

A volume of one cubic inch filled with globules, which we will suppose, for the sake of facility, to have only $\frac{1}{1000000}$ of an inch diameter, but placed in such a manner that the lines passing through their centres be perpendicular, or parallel, to each other, will present a surface of 218,166 square feet. In any other position the surface would be still greater if the globules touched each other. It is possible that platina black has a surface as considerable.

Wood charcoal is the most convenient substance for studying the action of large surfaces on gases, and the experiments of De Saussure, are, on this account, very important. Vegetable fibre does not melt when properly heated, so that the charcoal resulting from its calcination, still preserves the form of the fibre, as we may readily convince

ourselves, by placing the transverse section of a carbonized branch under the microscope. We discover every little cell of the plant, and we may assure ourselves that the form of the partitions have remained intact.

The cells of wood charcoal have, as a medium, a diameter of $\frac{1}{3400}$ of an inch; their surface would be equal, therefore, to 100 square feet, if the charcoal itself occupied no space. I prepared some wood charcoal, which weighed .9565 grains, and after boiling it some time in pure water, and wiping simply the surface of it, its weight was 2.2585 grains; its weight under water was .110 grains; the space into which the water had penetrated, and, consequently, into which elastic fluid might have penetrated after the expulsion of the latter, constituted then $\frac{1}{3}$ of the total volume of the charcoal; in reckoning the space occupied by the charcoal itself, we find that the extent of its surface is only 73 square feet. De Saussure found that wood charcoal absorbs 35 times its volume of carbonic acid at the temperature of 12 degrees, and under a pressure of 26.895; but 35 volumes of carbonic acid is found in a space which constitutes $\frac{1}{3}$ ths of the total volume of the charcoal, and, consequently, 56 times smaller than the space originally occupied by the carbonic acid.

Agreeably to the experiments of Addami, carbonic acid is liquified under a pressure of 36.7 atmospheres, at a temperature of 12 degrees. We are thence led to conclude that more than one-third of the carbonic acid which is condensed in the pores of the charcoal, is in a liquid state on the sides of the cells.

If 35 cubic inches of carbonic acid are condensed on a surface of 73 square feet, or 10,512 square inches, the thickness of the layer of liquid carbonic acid on the sides of the cells must be .000002 of an inch. This stratum is thicker when the experiment is made with ammoniacal gas, chlorhydric acid, or sulphurous acid, which do not require so enormous a pressure for liquefaction, and which are absorbed in more considerable quantities. Since all porous bodies, in presenting to the gas a considerable surface, act in the same manner as charcoal, we must admit that the gases which are in contact with solid bodies are in a peculiar state, and different from that in which they are when isolated from them; and moreover since the thickness of the layer of condensed gas varies, attraction is exerted not only on the gas which is in immediate contact with the solid body; it acts at variable distances. But porous bodies do not act at their surface only, for if it were so, the absorption of different gases by different substances ought to be in the same proportion. It is not thus, since, according to Saussure, wood condenses proportionally more carbonic acid than charcoal; also asbestos, spongy quartz, cotton, and silk tissues absorb different gases in proportions varying from that of wood charcoal.

The absorbent power of pulverulent substances has been hitherto but very little studied. Platina black, prepared by the method of Davy, far surpasses all others: 10 grains condense .550 cubic inch of oxygen; that is to say, one cubic inch of it would condense 253.440 cubic inches, (*Chimie de Platina*, by Dobereiner, page 64;) but it is

impossible to decide what the volume is which platina takes up when it condenses oxygen, because it is in a state of powder. The property which certain bodies possess, like silex, of condensing the humidity of the air, authorizes us to conclude that they have an aptitude in condensing gases.

As solids attract gases, they are capable, in like manner, of exerting this attraction over solid bodies; thus we may, by means of charcoal, deprive alcohol of the potatoe oil which it holds in solution. In boiling charcoal with water, the oil passes, unaltered, to the latter; this force of attraction carries off solid coloring matters from liquids which hold them in solution.

Some precipitates have the property of attracting a portion of the soluble salts from the fluid around them; they entangle and remove them, but washing sets them free.

I dissolved some nitrate of barytes in 10 parts of water; after having precipitated about half of it by sulphuric acid, I determined the quantity of nitrate of barytes which was held by the clear supernatant fluid. The fluid liquid, arising from the washing of the precipitate, was evaporated, and the nitrate of barytes which it contained was determined.

In subtracting the weight of this nitrate, and the weight of the sulphate of barytes obtained from the total weight of the wet precipitate, the weight of the water contained in the liquid was arrived at. In calculating, from these data, on the one part, the weight of the nitrate of barytes in the liquid which overflowed the sulphate, and on the other part, that of the liquid which moistened the precipitate, it was found that two-thirds only of the latter was dissolved in it, and that the one-third contained in the water used in washing must have been condensed by the attraction exerted by the precipitated sulphate. If, instead of precipitating a solution of barytes, we employ the chloride of barium, the latter is thus drawn away. But if we precipitate a solution of nitrate and sulphate of soda, by nitrate of barytes, and wash the precipitate until a drop of the washing leaves no trace of solid matter on a platina blade, it happens, in this case, that the sulphate of barytes may retain as much as two per cent. of nitrate of soda; to remove it the precipitate must be calcined, and then washed.

The sulphate of barytes, therefore, exerts an attraction so weak on the chloride of barium as to be unable to remove it from its aqueous solution; but with respect to the nitrate, the attraction is so strong as to render a great quantity of water necessary to clear it; but water is incapable of removing completely, from sulphate of barytes, the nitrate of soda which it retains at the moment of its formation.

One may very easily judge of the force of attraction which solid bodies exert upon each other by considering the action of cement upon wood and glass. If we cover a plate of glass with moist bladder, and, when dry, try to detach it, we tear off portions of glass. The action of the bladder upon the glass is stronger, therefore, than the cohesion of molecules of the glass itself; but if we allow the plate of glass and bladder to remain some time in boiling water, the gelatine is dissolved, and the bladder is easily removed.

Although this attraction is very strong, it is less considerable than that of sulphate of barytes for nitrate of soda. The attraction which solid bodies have for liquids and gases is manifest not only by immediate contact, but also at a determinable distance. We may prove it by using plates of glass, or of quartz, having two perfectly smooth faces. The first is to be suspended, and the other furnished with the means of attaching weights. I deprived two plates, thus disposed, of all adhering humidity; the thinnest layer of it interposed, shows itself by the production of the colored rings of Newton. By compressing these plates afterwards, until the colored rings begin to appear, we may easily determine their distance. At the appearance of the second ring, the lower plate, whose weight was 14 grammes, remained attached to the first. The contiguous surfaces were but one inch square; when pressed together, so that the black appeared over nearly the whole of the first ring, several pounds might be suspended from it. By having this apparatus for some time under the air pump, the plates did not separate, so that atmospheric pressure was not the cause of their adherence.

We know that this kind of attraction takes place generally during the crystalization of bodies. A body dissolved deposits itself on threads, or solid bodies, suspended in the liquid, much quicker than if these are not present. Crystals are formed much faster around a crystal already formed than in any other portion of the liquid, when, for example, the force of the solvent is lessened by a diminution of its temperature. The solvent force of water is, therefore, less energetic near a formed crystal than at a certain distance from it.

In some cases it is easy to account for the chemical combinations which the action of solid bodies on liquids and gases may excite, but in others the explanation becomes more difficult. It is possible that condensation alone may be the cause of it in gaseous bodies. We may, in this way, very well explain the distinction which M. Thenard observed, on introducing charcoal into a mixture of sulphhydric acid and oxygen. When platina black, which has condensed oxygen, is placed in contact with chlorhydric acid, there results, according to Dobereiner, chloride of platina. We know that, in this case, the condensed oxygen may readily seize the hydrogen of the acid; and yet the affinity of chlorine for platina interferes in the case. The affinity of gold for chlorine provokes the decomposition of nitric acid by chlorhydric acid, when leaves of gold are placed in aqua regia, since the latter contains free chlorine only after it has been warmed, or after being for a long time left to itself.

When a gas is in the nascent state, a phenomenon is presented analogous to those just mentioned; the gas combines often with a body in contact with it, which, in other circumstances, would produce no action upon it. Thus, in the cases in which the chemical affinity of two gases is weak, it may happen that their condensation causes them chemically to combine.

Nevertheless it appears doubtful whether we ought to attribute the combination of two bodies, which, like oxygen and hydrogen, have so strong an affinity for each other, to the effects of condensation alone,

though we may be authorized to grant that in the various physical conditions of platina a condensation of gas takes place at its surface.

We know that in leaf and in fine wire, platina acts as well as in the precipitated, or spongy, state, or in black; but the combination is slower as the surface used is more limited.

The leaves and sponge of platina do not condense a large quantity of oxygen; but in comparing their surfaces with that of platina black, we perceive that it ought to be so. The sponge of platina arising from the decomposition of the double chloride of platina and potassium is formed at a temperature at which the mixture begins to agglomerate, and presents itself under the form of plates, which cannot certainly possess a surface large enough to admit of an easy appreciation of gaseous condensation.

An experiment first made by M. Fusinieri, and is easily repeated, proves that air and moisture are condensed on the surface of glass. If we pour into a glass tube boiled mercury, which has been cooled in a vacuum, we find that it gives out air, when heated, even when the precaution is taken to assure ourselves by the microscope, that no traces of it adhere to the sides of the glass; but if into a tube of glass which has been exposed to a high temperature, we pour mercury by means of a funnel whose point touches the bottom of the tube, and then heat the tube, not a bubble of air escapes, even when mercury is used which has been agitated with air and water, and left to dry by simple exposure to free air. The gaseous bubbles then which the mercury, in the first experiment, yielded, must have come from the air and moisture condensed on the sides of the tube; but the quantity of air and water, thus condensed, is so trifling, its presence can only be proved by such an experiment as above stated.

It would be impossible to prove the condensation of any gas whatever on the surface of platina leaves, even supposing it to be as considerable as that of the carbonic acid on the surface of charcoal.

A mixture of alcohol and oxygen act, in the presence of platina, absolutely in the same manner as a mixture of oxygen and hydrogen. Oxygen is devoid of action on weak, or concentrated, alcohol. Platina black provokes their combination. Other bodies also do the same. It has been thought that to effect this reunion it was necessary to recur to the use of ferments; but M. Duflos has proved that chips of wood, soaked in acetic acid, act in a manner analogous to platina black. One might have supposed that the acetic acid thus used had deposited some ferment on the wood; but these ferments would soon have been decomposed by the oxygen of the air, and M. Duflos has proved that with chips, or shavings, alone, we may transform alcohol into acetic acid for months together.

When acetic acid is prepared by exposing beer, or fermented liquors of this kind, to the action of air, they become turbid, and deposit matters of an organic nature. These spongy matters, acting after the manner of platina black, will condense oxygen, and thus determine the combination of these bodies.

To be Continued.