

Letters to the Editor

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NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 169.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Order of Affinity of Metals for Copper, Iron, Cobalt and Nickel

EACH of the metals aluminium, zinc, cadmium, tin, mercury and lead is known from X-ray and thermal data to form intermetallic compounds with copper. Some of these may be prepared also by obtaining the two metals in dilute solution or suspension (1-4 per cent) at the ordinary temperature in mercury and removing excess of the more reactive metal by oxidation and the mercury by filtration and distillation¹. In mercury, under such conditions, there is in each system a binary compound much stabler than the others, namely, AlCu_3 , Sn_4Cu_5 , ZnCu , CdCu_4 , Hg_3Cu . The question arises: Suppose we have two of the above metals competing for copper in the medium of mercury, do both combine with copper or does one only? Or, suppose we add one metal to the compound of another metal and copper, is there a partial reaction, or does the reaction go either completely or not at all?

The analytical difficulties of this problem are not serious, and it is possible to obtain unambiguous answers to these questions. There seems to be a definite order of the above metals with respect to their power to combine with copper. It is aluminium, tin, zinc, cadmium and mercury, lead. If copper be competed for by two of these metals, the one earlier in the list combines with it, the other remains uncombined. If a metal earlier in the list be added to a compound of copper and another of these metals, the former displaces the latter completely. If the positions are reversed, no reaction occurs. Thus, when aluminium is added to any tin, zinc, cadmium or lead compound of copper, in mercury, it combines with the copper and sets the other metal free. The resulting binary is AlCu_3 or, more often, the stabler ternary $\text{Al}_2\text{Cu}_3\text{Hg}_8$. From neither of these can the aluminium be displaced by any of the metals mentioned. So for the action of tin on zinc-copper compounds. Ternary and even quaternary complexes are temporarily formed², but in the end the zinc is wholly displaced and the tin combines with the copper. Ternaries throughout complicate the issue.

Similar experiments have been done with these metals and the metals iron, cobalt and nickel, with which each of them is also known to combine. With iron the stabler compounds formed are AlFe_3 , SnFe_3 , ZnFe_7 and HgFe_4 (cadmium and lead do not readily combine in mercury with transition elements). The order here is aluminium, tin, zinc, mercury, cadmium and lead. Thus, neither tin nor zinc can displace aluminium from AlFe_3 , whereas the easiest way of preparing this compound is by adding aluminium to a tin-iron or a zinc-iron compound in mercury.

With cobalt the stabler compounds formed are AlCo , SnCo_2 , ZnCo and HgCo ; with nickel the stabler compounds are AlNi , Sn_4Ni_5 , ZnNi and HgNi . With both these metals the order is that obtained with iron and slightly different from that obtained with copper. The corresponding experiments with manganese and silver have still to be done. The inverse problem—How does one of the metals aluminium, tin and so on, distribute itself among the other metals of the class copper, silver, iron and so on?—is analytically very hard and has not yet been solved.

The order of metals obtained in these experiments is not, and would not be expected to be, that of the electrode-potential series, because in entering into intermetallic combination the atom does not undergo the simple process of ionization of the type $X \rightarrow X^+$. It is likely to be connected with atomic diameters and interatomic distances and forces in the crystal patterns formed.

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¹ Russell and others, *J. Chem. Soc.*, 841, 852, 857, 2340 (1932); 1750 (1934).

² Russell, *NATURE*, **133**, 217 (1934).

Formation of Carbon Dendrites

PARTICLES of colloidal graphitic oxide dispersed in water have a negative charge, and under a potential gradient move relatively rapidly towards the anode¹. Under certain conditions, however, reduction of the oxide occurs at the cathode, with the formation of long carbon dendrites. This phenomenon was shown in striking manner under the following conditions.

Graphitic oxide was prepared from finely divided Ceylon graphite by treatment with the usual sulphuric, nitric acid, potassium chlorate mixture and the product washed with water. After five washings, the colloidal, supernatant, slightly viscous, brown opalescent solution (pH 2.88) was decanted into an inclined glass tube provided with two platinum electrodes (see Fig. 1). On applying a potential of approximately 200 volts between the electrodes, the disordered micellar lamellæ orientated themselves so that their faces were at right angles to the path between the electrodes (cf. Thiele¹), and immediately thin carbon dendrites commenced to grow from the cathode, and the colloid started to collect round the anode.

These effects are clearly shown in Fig. 1 (A), which was made one second after switching on the potential. They have become much more pronounced 25 sec.