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A Volatile Compound of Copper

IN search of the cause of a copper deposit formed in some incandescent lamps with copper electrodes, we examined the thermal decomposition of some organic copper salts. Cuprioxalate yields copper oxides, and cuprimesoxalate a mixture of copper oxides with elementary carbon. Cupriformate, however, decomposes at about 200° C., evolving partially a volatile compound of copper which immediately decomposes, forming a red smoke of elementary copper, and coating the near hot glass surface with a brilliant mirror of metallic copper. Where this mirror was thin, it resembled in every way the red deposit found in incandescent lamps.

Cupriformate may be decomposed in a horizontal glass tube in a stream of non-oxidizing gas, and its volatile product of decomposition is thus carried quickly out of the hot zone and saved from decomposition. It may be transported by the gas through a dense filter of cotton wool several centimetres long in a glass tube over a distance of more than 40 cm., and if the gas is ignited there, the new compound makes the flame an intense green. If, however, a remote part of the tube through which the compound is swept by the gas is heated externally, a beautiful copper mirror is formed. The unheated part of the tube between the cupriformate and the heated section remains absolutely clear. In a preliminary experiment, more than 1 per cent of the copper present in the decomposed cupriformate was recovered in the remote mirror. This reaction is useful in the quantitative study of the behaviour of the new compound, the isolation of which has not yet been accomplished. It is readily adsorbed on glass wool and to some extent on cotton. It condenses together with droplets of water—resulting from the formate—on the glass tube, and may be driven thence by gentle heating. The diluted gas stream is uncoloured; but around the decomposing cupriformate the gas phase is sometimes olive-green.

Formates of nickel, iron, cobalt, zinc and cadmium decompose without mirror formation. The extremely labile silver formate, however, yields a mirror on thermal decomposition, and silver oxide does the same when heated in a stream of reducing gas containing formic acid vapour. It is interesting that this reaction of the formates is not observed with the carbonyl-forming metals but occurs with two metals of the first sub-group of the periodic system. Experiments with gold are in progress. *Feb. 21.*

The existence of a copper carbonyl has been already postulated[1–4] but was seemingly disproved by Mond and Heberlein[5], who found no copper mirror in a glass tube after passing a mixture of carbon dioxide and monoxide over cupric oxide. In a recent communication in *Nature*, H. Bloom[6] reports having confirmed Bertrand's[2] original claim. His experiments are convincing in respect to the formation of a volatile copper compound, which is probably identical with the one formed from cupriformate. The term 'copper carbonyl', however, needs further examination. At the beginning we also thought that we were dealing with a carbonyl, but the facts that (1) the formates of the carbonyl-forming metals are inactive and (2) that of the three copper salts examined the two yielding carbon monoxide and dioxide were inactive, and only the formate, which contains hydrogen, was found active, made us hesitate. Experiments quite similar to those of Bloom showed mirror formation only if at least traces of organic compounds containing hydrogen were present in the gas. Metallic copper never reacted, only the oxide, and that only if a reducing gas was used. It would be very interesting to repeat Bloom's experiment with carbon monoxide carefully purified from all traces of hydrogen compounds. Convincing evidence will be available only after isolation and analysis of the new compound. Experiments to this end are in progress.

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Action of 2-Aminofluorene on Moulds

Bielschowsky and Green[1] have noticed that 2-aminofluorene at a concentration of 1 : 10,000 is a growth inhibitor for *Staphylococcus aureus*. Such observations have been confirmed[2] and amplified by us. The influence exercised by this compound on two strains of *Penicillium* studied by us seems to us to be of particular interest.

Penicillium notatum Westling, strain 1219, is considerably hindered in its growth by saturating with 2-aminofluorene the Czapek–Turley medium, in which this substance dissolves only in traces. It is necessary first to sterilize the aminofluorene and then add it to the medium, otherwise the composition would be changed by heating. It seems that only sterile hyphæ are formed; there is no formation of characteristic conidiophore filaments. The hyphæ in coloured preparations appear to end with simple club-shaped swellings, or are reduced to fragments without causing the formation of conidia (see photographs); only very slowly does a sign appear of the formation of exospores.