Huygens Institute - Royal Netherlands Academy of Arts and Sciences (KNAW)

Citation:

E. Cohen, The metastability of the metals in consequence of allotropy and its significance for chemistry, physics and technics, in:
KNAW, Proceedings, 16 II, 1913-1914, Amsterdam, 1914, pp. 632-634

This PDF was made on 24 September 2010, from the 'Digital Library' of the Dutch History of Science Web Center (www.dwc.knaw.nl) > 'Digital Library > Proceedings of the Royal Netherlands Academy of Arts and Sciences (KNAW), http://www.digitallibrary.nl'

attention to the following curious historical peculiarity: THEOPHRAST (a pupil of ARISTOTLE) says in his book *περὶ πυρός: καττίτερον γάρ φασὶ καὶ μόλιβδον ἤδη ταχῆναι ἐν τῷ Πόντῳ πάγου καὶ χειμῶνος ὄντος νεανικοῦ, χαλκὸν δὲ ῥαγῆναι.* (It is told that tin and lead melted sometimes in the Pontos when it was very cold in a strong winter and that copper was disintegrated).

10. The properties of copper α and β as well as some problems relating to the technical use of copper will be discussed shortly.

VAN 'T HOFF-*Laboratory.*

Utrecht, December 1913.

Chemistry. — "*The metastability of the metals in consequence of allotropy and its significance for Chemistry, Physics and Technics.*" By Prof. ERNST COHEN.

1. The research which I have carried out during these last few months in collaboration with A. L. TH. MOESVELD and W. D. HELDERMAN, has proved that several metals which until now were only known in one modification are capable of existing in two (or more) allotropic forms. The continuation of these investigations will show if all metals have this property, but we may even already conjecture that this will be the case. A great many observations described in the earlier literature afford evidence in this direction.

2. We were also able to state the fact that the pure metals as we have known them until now are *metastable* systems consisting of two (or more) allotropic forms. This is a consequence of the very strongly marked retardation which accompanies the reversible change of these allotropic modifications both below and above their transitionpoints. Employing certain devices (using the metals in a very finely divided state, adding an electrolyte) it is possible to increase the transition-velocity in such a degree, that the change of the metastable to the stable form occurs within a short time.

As such changes are very often accompanied by marked changes of volume, the material is generally disintegrated.

3. As until now, chemists and physicists have always dealt with the α- and β-form together, *all* the physical constants of metals, which have been determined, refer to the complicated metastable systems. These are entirely undefined as the quantities of the α- and β-modifications they contain are not known.

Now it is known that a special physical property of any substance at a definite temperature and pressure depends on its allotropic

condition. H. F. WEBER [1]) found the specific heat of carbon (at 10° C.)

0.1128 in the form of diamond
0.1604 „ „ „ „ graphite
0.1653 „ „ „ „ charcoal

ERNST COHEN and E. GOLDSCHMIDT [2]) found that the density of *white* tin is 7.28, that of *gray* tin 5.8 (at the same temperature) while KÔTARÔ HONDA [3]) has stated that the specific magnetic susceptibility ($\chi \times 10^6$) of *white* tin is $+ 0.025$, while that of *gray* tin is $- 0.35$ at the same temperature. Here even the sign is changed. The existing data on the physical constants of metals known until now are thus to be considered as entirely fortuitous values which depend on the previous thermal history of the material used. Those physical constants, which refer to a well defined condition of the metal are so far unknown. In order to determine these, and only these have a definite signification and are reproducible, we shall have to carry out in the future all measurements for the *pure* $\alpha, \beta, \gamma \ldots$. modifications of the metals.

4. Considering for instance the important part which the specific heats of the metals have played in chemistry and physics during the last few years, it is evident that a revision of these constants is wanted.

5, What has been said about the specific heat holds evidently for every other physical constant. In our paper on the allotropy of bismuth [4]) we pointed out, that numerous phenomena which had been observed in the study of density, electric conductivity (also under pressure) conductivity for heat, melting point, thermoelectric force, the HALL-effect etc. and which had not been explained, may find their explanation if the facts recently found are taken into account.

6. In this way a new field of research for chemists as well as for physicists presents itself. Whilst it will be the task of the chemist to prepare the pure modifications and study their physico-chemical properties, the physicist will require to turn his attention to the determination of their physical constants.

7. From a physico-chemical standpoint it will be very important to study the electromotive behaviour of the allotropic modifications mentioned above. The transitioncell of the sixth kind which I

[1]) Pogg. Ann. **154**, 367, 553 (1875).

[2]) Zeitschrift für physik. Chemie. **50**, 225 (1905)

[3]) Ann. d. Physik **32**, 1027 (1910) ; The Science Reports of the Tôhoku Imp. Univ., Sendai, Japan. **1**, 1 (1912).

[4]) Zeitschr. f. physik. Chemie **85**, 419 (1913).

described several years ago [1]) may be used for this purpose. In this way it will not only be possible to determine the heat of transformation of the modifications, but also to study the equilibrium between the different forms. Several interesting problems may find their solution in this way. I have carried out some preliminary experiments in this direction (with cadmium) in collaboration with Mr. W. D. HELDERMAN.

8. The same may be said if we consider the numerous alloys which have an industrial as well as a scientific interest.

The melting point curves have to be revised, taking into account the allotropy of the components. Quite recently the important part played by the previous thermal history of alloys has been discovered. DIPPEL [2]) has proved that the specific heat of certain alloys is different according as they are chilled or cooled slowly.

In explaining this fact, DIPPEL has not been able to take into account the allotropy of the components of the alloys he experimented with, as our papers on this subject could not at that time be known to him.

9. I hope to report shortly on the problems which have been indicated here. We will then discuss also several phenomena which are observed in industry, the corrosion of metals in contact with water, rusting of iron, the decay of aluminium objects etc.

Utrecht, December 1913. VAN 'T HOFF-*Laboratory*.

Anatomy. — "*On pteric sutures and pteric bones in the human skull*". By Prof. A. J. P. v. d. BROEK. (Communicated by Prof. L. BOLK).

It is well known that the pteric region of the skull shows different relations in form and extension of the adjacent sutures as well as in the existence of separate bones, the so called pteric bones, ossa epipterica.

In most of the human skulls the parietal and the ala magna of the sphenoid touch in a more or less extensive spheno-parietal suture.

In some skulls the frontal is reached by the temporal bone, then a fronto-temporal suture is formed. In this case we speak of a processus frontalis ossis temporalis.

The configuration of the pteric region can be influenced by the number, form, extension and situation of the pteric bones.

[1]) Zeitschr. f. physik. Chem. **30**, 623 (1899).

[2]) Ann. d. Physik **42**, 889 (1913).