gleichung für die t-jährige Überlebenswahrscheinlichkeit eingesetzt, so folgt für das Deckungskapital[1] der gemischten Versicherung «1»

$$\frac{l_{x+t}}{l_x} = \frac{1}{1-{}_tV_{x:\overline{n}|}} e^{-\int_0^t P_{x+\lambda:\overline{n-\lambda}|}\,d\lambda} \qquad (1)$$

In der diskontinuierlichen Betrachtungsweise besteht zu (1) eine absolute Parallele. Aus der Differenzengleichung des Deckungskapitals der gemischten Versicherung «1»,

$$\Delta_t V_{x:\overline{n}|} = i\,[{}_tV_{x:\overline{n}|} + P_{x:\overline{n}|}] + P_{x:\overline{n}|} - q_{x+t}\,[1 - {}_{t+1}V_{x:\overline{n}|}]\,,$$

folgt bei Auflösung nach p_{x+t} und nach Einführung der Prämie $P_{x+t:\overline{n-t}|}$

$$p_{x+t} = \frac{1-{}_tV_{x:\overline{n}|}}{1-{}_{t+1}V_{x:\overline{n}|}}\,[1-(1+i)\,P_{x+t:\overline{n-t}|}]$$

und damit

$$\frac{l_{x+t}}{l_x} = \frac{1}{1-{}_tV_{x:\overline{n}|}} \prod_{\lambda=0}^{t-1} [1-(1+i)P_{x+\lambda:\overline{n-\lambda}|}]\,. \qquad (2)$$

Gleichung (2) ist geeignet, das Deckungskapital zusammengesetzter Versicherungsformen – gemischte Versicherung auf verbundene Leben, Versicherung anormaler Risiken – näherungsweise durch das Deckungskapital einfacher Versicherungsformen – gemischte Versicherung auf ein Leben, Versicherung normaler Risiken – darzustellen. Ebenso läßt sich eine Näherungsformel für das Deckungskapital bei Variation des Zinsfußes angeben.

E. ZWINGGI

Versicherungstechnische Abteilung des mathematischen Seminars der Universität Basel, den 18. März 1946.

Summary

The author derives from the differential equation for the annuity and from the difference equation for the value of the policy several relations, which allow to represent approximately the value of composed forms of insurances by the value of simple forms of insurances; likewise, it is easy to render formally the influence of a variation of the rate of interest.

[1] Diese Gleichung kann man auch unmittelbar aus der Differentialgleichung für das Deckungskapital erhalten; vgl. E. ZWINGGI: Ein Multiplikationssatz für das Deckungskapital. Mitt. der Vereinigung schweiz. Versicherungsmathematiker, *45*, 375–383 (1945).

Crystal Structure of Barium Titanium Oxide at different Temperatures

Barium titanium oxide (barium titanate) has a structure of the well-known perovskite type. It has however been shown recently (MEGAW[1] 1945, ROOKSBY[2] 1945) that it is not strictly cubic, but tetragonal. Its unit cell is derived from the ideal cubic by a small change of dimensions without change of atomic parameters. It has a transition temperature about 120° C, above which it becomes cubic with the ideal perovskite structure.

The occurrence of the tetragonal structure is puzzling and difficult to explain on existing evidence. The ideal cubic structure would require anomalous ionic "radii" for one or other of the cations (MEGAW[3] 1946) and hence some modification is to be expected; but the tetragonal modification actually assumed does nothing to remedy the anomaly. Moreover, the retention of the small cell implies that the tetragonal symmetry is inherent in the individual coordination polyhedra surrounding the cations, and is not merely a consequence of their relative arrangement.

The only possible explanation seems to be the existence of a set of bonds of tetragonal symmetry in the lattice, superimposed on the mainly ionic forces. For the origin of these bonds only tentative suggestions can be put forward, though it seems likely that they are facilitated by the abnormally large volume available to the Ti ion. They may be covalent Ti–O bonds of the kind dealt with by PAULING and HUGGINS[1] (1934), or perhaps Ti–Ti bonds of the sort discussed by KLEMM[2] (1939); there is not sufficient experimental evidence to be clear on this point. However, the existence of the bonds, as apart from their nature, is a direct deduction from the structure.

The changes in the structure with temperature have been investigated experimentally. Powder photographs were taken in a 19 cm high-temperature camera at intervals of a few degrees over a range including the transition point; and some rough experiments were also made at low temperatures, approximately −78° C and −183° C. Measurements of the high-temperature photographs, using a modified Bradley-Jay extrapolation, gave the cell dimensions, axial ratio, and linear thermal expansions along and perpendicular to the tetrad axis; from the low-temperature photographs, rough estimates of the axial ratio could be made.

The unit cell retains its identity throughout the transition. The axial lengths vary continuously with temperature, though not linearly, the variation becoming more rapid near the transition point. While the linear expansion coefficients along and perpendicular to the axis are large and of opposite sign and vary with temperature, the volume expansion coefficient is small, positive, and constant within the accuracy of measurement. There is no discontinuous change either of linear spacing or of volume detectable at the transition point, but there is a sharp discontinuity in the linear expansion coefficients and probably (though not certainly) in the volume expansion coefficient, whose value for the cubic structure is approximately three times what it is for the tetragonal.

Coexistence of cubic and tetragonal structures, in proportions depending on the temperature, occurs over a range of some degrees near the transition point. This may be effected by local stresses which facilitate or hinder, according to their direction, the change between two structures whose energy difference is very small in this range. There is a close resemblance here to what happens in ammonium chloride (DINICHERT[3] 1944).

Below room temperature, there is a *decrease* of axial ratio, suggesting that the structure may have a second transition point somewhere below −183° C and become cubic again. The change is likely to be of the same general nature as that at the upper transition point. The occurrence of a double transition of a similar kind is met with in Rochelle salt (UBBELOHDE and WOODWARD[4] 1945).

All these features suggest a typical λ-point change. The specific heat has not been determined, but the

[1] H. D. MEGAW, Nature *155*, 484 (1945).
[2] H. P. ROOKSBY, Nature *155*, 484 (1945).
[3] H. D. MEGAW, Proc. phys. Soc. (1946).

[1] L. PAULING and M. L. HUGGINS, Z. Krist. *87*, 205 (1934).
[2] W. KLEMM, Z. Elektrochem. *45*, 583 (1939).
[3] P. DINICHERT, Helv. phys. acta *17*, 389 (1944).
[4] A. R. UBBELOHDE and I. WOODWARD, Nature *155*, 170 (1945).

thermal expansion curve has the characteristic λ-shape. It is interesting to notice that here, as in the α—β-transition in quartz, the λ-point phenomena cannot possibly be attributed to the setting in of rotation in any molecules, ions, or groups. What the actual mechanism may be still remains an open question.

It is probable that the two transitions are associated with changes in the bond system. At low temperatures the bonds may have an octahedral formation, and they would then require in the structure as a whole the same cubic symmetry as do the ionic forces on which they are superimposed. With increasing temperature this bond system breaks down, but it does so in two stages, with the intermediate formation of a square set of bonds which has tetragonal symmetry. The final breakdown of the tetragonal bonds gives rise to the transition at 120° C: above this, the purely ionic forces result in a cubic structure.

There are certain anomalies in the intensities of the X-ray lines near the transition point which it is possible to explain in a qualitative way by means of this hypothesis.

It is hoped to publish a fuller account of this work shortly.

I should like to express my thanks to Dr. D. F. RUSHMAN in connection with whose work this investigation was undertaken, and I am greatly indebted to Sir LAWRENCE BRAGG for permission to use the high-temperature camera in the Crystallographic Laboratory, Cambridge, for a part of the work.

Finally I wish to thank Mr. VAN MOLL and the Directors of Philips Lamps Ltd. for permission to publish this paper.

H. D. MEGAW

Material Research Laboratory, Philips Lamps Ltd., Mitcham Junction, Surrey, March 25, 1946.

Résumé

L'auteur a étudié aux rayons X la transition du titanate de barium autour de 120° C. Dans un intervalle de quelques degrés, il y a coexistence des deux formes cristallines (tétragonale et cubique). Il semble probable qu'il y a une nouvelle transition près de −183° C. Il est intéressant de noter que ces points λ ne peuvent pas être attribués à une mise en rotation de molécules.

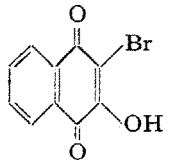
Etude du métabolisme d'une substance affectant la coagulation sanguine par la méthode des indicateurs radioactifs[1]

Malgré de nombreuses recherches, le problème du mécanisme de l'action des vitamines K et des substances «hémorrhagiques» (méthylène-bis-oxycoumarine) sur la coagulation du sang n'a pu encore être éclairci.

On admet, en général, que les substances douées de ces activités agissent sur la sécrétion de la prothrombine par l'organisme, mais ni le lieu ni les particularités de la fixation de ces corps n'ont encore pu être précisés. Dans l'état actuel de nos connaissances, on peut assigner aux vitamines K et à leurs antagonistes des voies de transport et des lieux de fixation analogues, et il suffit d'acquérir des éclaircissements sur le sort des uns pour projeter également quelque lumière sur celui des autres.

[1] Voir P. et R. DAUDEL, M. BERGER, NG. PH. BUU-HOÏ et A. LACASSAGNE, Exper. *2*, 70 (1946).

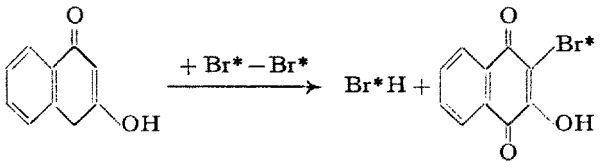
Une substance «hémorrhagique» très simple est la 2-bromo-3-hydroxy-1:4-naphtoquinone (I), et on peut



(I)

aisément la «marquer» en la préparant à l'aide de radiobrome. Nous avons pu ainsi suivre son destin dans l'organisme.

Le corps (I) est préparé par action du radiobrome sur la 3-hydroxynaphtoquinone à l'ébullition et en dissolution dans l'acide acétique:



Le radiobrome est obtenu comme d'ordinaire (I) par irradiation de bromure d'éthyle à l'aide des neutrons lents fournis par le cyclotron du laboratoire de M. le Prof. JOLIOT-CURIE. Le produit marqué est injecté sous forme de solution huileuse par voie sous-cutanée à des souris mâles, à la dose de 5 mg par animal. Ces souris sont sacrifiées par décapitation, 20 minutes, 12 heures, 17 heures et 40 heures après l'injection[1].

La radioactivité des préparations obtenus et la courte période du brome ne nous ont pas permis d'aller plus loin. Les organes sont examinés au compteur de Geiger-Müller selon la technique classique. Nous avons mesuré séparément l'activité du plasma et des globules en lavant soigneusement le culot de centrifugation avec du

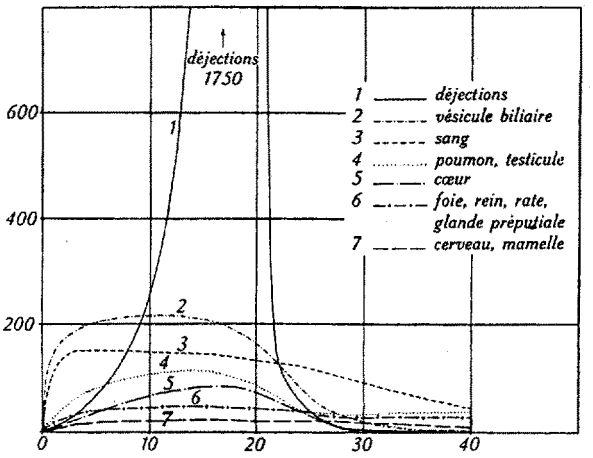


Fig. 1. Variation de la concentration dans divers organes du corps (I) (exprimés en γ par g d'organe) en fonction du temps (en heures).

sérum physiologique. Les mesures faites sur 2 lots différents d'animaux nous ont donné des chiffres tout à fait comparables.

Les résultats sont résumés par les figures 1, 2 et 3 sur lesquelles les abscisses sont exprimés en heures et les ordonnées en γ (0,001 mg) du corps (I) par gramme d'organe.

[1] Au sujet des antivitamines K, consulter les travaux de P. MEUNIER *et al.*, Bull. Soc. Chim. biol. *24*, 371 (1922); *25*, 384 (1943); etc.