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THE OXIDE-COATED CATHODE

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VOLUME TWO

PHYSICS

INCLUDING THERMAL EMISSION FROM METALS AND SEMI-CONDUCTORS

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PREFACE

VOLUME TWO

THE physics of the oxide-coated cathode must of necessity be based on foundations which are much wider in scope than those for cathodes consisting simply of metals. This is due to the fact that the oxide cathode is an ionic solid and that for investigating the mechanism of its electron emission it is necessary also to take into account the phenomena of electrical conduction and diffusion in such solids. A separate review of the physics of the oxide cathode seems therefore justified.

When work on such a review was started, it was thought that it could be confined to a discussion of experimental work and its theoretical interpretation on oxide cathodes alone. It was soon realized, however, that an adequate knowledge of some of the fundamentals which had to be used could not be assumed in the case of every reader. There were few up-to-date reviews of such fundamentals which could be relied upon and many controversial points requiring clarification. The subject matter of the book had therefore to be extended to the discussion of these fundamentals, which are presented under the main headings of "Thermal Emission" and "Phenomena in Ionic Solids." In addition to these two subjects a special chapter has been devoted to a critical discussion of the methods for measuring the work function of electron emitters. As these basic ideas make up about one-half of the present volume, the sub-title "Thermal Emission from Metals and Semi-Conductors" has been chosen for it.

When discussing thermal emission in general a choice had to be made between two possible ways of attacking this problem, namely, by thermodynamical or by statistical methods. It was felt to be impracticable to use both methods simultaneously or even alternately in different sections. The statistical method was chosen because it allows a clear visualization of the behaviour of the emitting electrons. No inference, however, should be drawn from this choice on the suitability of the thermodynamical method, which, as is well known, has the advantage of giving more universal results.

When dealing with the physics of the oxide cathode itself, a

model of its fundamental mechanism had to be adopted. The so-called semi-conductor model, which has come into the foreground during the last fifteen years, seemed to be the most suitable for this purpose, and it has been attempted to prove that this model gives a reliable basis for further investigations. A special chapter has been devoted to this end where all secondary phenomena such as effects of core metals and residual gases have been deliberately neglected. The use of the term "secondary" for these phenomena only refers to their connection with the mechanism of emission and bears no relation to their practical importance. It is fully recognized that it is in fact these phenomena which inhibit the application of oxide cathodes in practice, and a detailed discussion of them has therefore been given in the two concluding chapters.

Naturally, the treatment of the subject matter had to be rather broad owing to the large number of investigations and to the inconsistencies of some of the results. It was thought to be necessary to discuss, or at least to mention, every work on oxide cathodes which has been published, and it is hoped that such a treatment will be of advantage not only to the newcomer on the field but also to those who have been working on it for many years. The literature has been covered up to the beginning of 1950.

The units generally used in this book are Giorgi's rationalized M.K.S. units (meter, kilogram, and second and the appropriate electrical units, volt, ampere, etc.). Only in a few cases was the application of these units felt to be unsuitable, as, for instance, when using densities. Densities (of mass) have been given as usual in g./cm.^{3}, current densities in amp./cm.^{2}, and electron densities have generally been referred to 1 cm.^{3} as the unit volume. However, wherever units other than the rationalized ones have been employed, this has been explicitly stated.

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