THE THEORY AND PROPERTIES OF THERMOCOUPLE ELEMENTS

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THE THEORY AND PROPERTIES OF THERMOCOUPLE ELEMENTS

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Foreword

In this work, *The Theory and Properties of Thermocouple Elements*, Professor Pollock has written a singularly useful monograph which should appeal to a wide variety of readers, ranging from the advanced undergraduate or graduate student who is just beginning to get his feet wet in this area to the sophisticated specialist who wants to brush up on his fundamentals. More particularly, the work provides a worthwhile gathering of information of a theoretical nature on metallic thermocouples. Consider only the topics included: here, under one cover, we find the history, thermodynamics, mathematics, quantum mechanics, and physics of thermoelectricity, all neatly compiled and stored for us. A careful perusal of this material is bound to lead to a greater understanding of the behavior of thermoelectric metals in terms of the solid state physics involved.

R. P. Benedict

Westinghouse Electric Corp.

Related ASTM Publications

Manual on the Use of Thermocouples in Temperature Measurement, STP 470 (1970), $17.00

Specifications for Thermocouples, Sheathed, Type K, for Nuclear or for High Reliability Applications (E 235 - 67)

Liquid Baths for Thermocouple Measurements, Proposed Standard, 1970 Annual Book of ASTM Standards, Part 30

Preparation of Thermocouple Measuring Junctions, Proposed Standard, 1970 Annual Book of ASTM Standards, Part 30

Properties of Thermoelement Materials, Proposed Standard, 1970 Annual Book of ASTM Standards, Part 30

Preface

This monograph was written in an attempt to fill a long standing void in the literature on thermoelectricity. The book by D. K. C. MacDonald, *Thermoelectricity: An Introduction to the Principles*, Wiley, 1962, considers the theory and thermoelectric behavior of alloys below their characteristic temperatures. Other works, such as the *Manual on the Use of Thermocouples in Temperature Measurement, ASTM STP 470*, 1970, contain sections which are concerned primarily with the more practical and applied aspects of thermoelectric thermometry at elevated temperatures.

The present work attempts to explain the theory and the bases for the thermoelectric behavior of alloys in general and of those alloys commonly used for thermoelectric purposes at temperatures above their characteristic temperatures in particular. This is the range in which the vast preponderance of the applications have been and are being made. No single work which satisfies this need has yet come to my attention.

The text is designed to assist the novice, as well as the reader who has some familiarity with this field, to acquire a more fundamental understanding of this behavior in metallic conductors. Semiconductors are not included. It has been written so that only a knowledge of elementary calculus is required to follow the reasoning. All of the algebra is shown, and no steps in the derivations are considered to be "obvious" to the reader. Introductory material is provided in order to facilitate the understanding of the relevant concepts in thermoelectricity and solid state physics.

Most of the elementary knowledge required for the understanding of chapter 4 is given in the Introduction. However, chapters 2 and 3 will permit the novice to omit the derivations given in chapter 4. One may skip these and go on to the discussion at the end of that chapter with little loss in understanding. The Mott and Jones theory is given for the more sophisticated reader and because it does not appear to have been presented in elementary detail elsewhere. The combined presentations given in chapters 2, 3, and 4 are thought to provide a broader basis for the understanding of thermoelectric phenomena than is possible from any one explanation by itself.

Basic material already well represented in the literature is included in a minimal way for the sake of completeness. Other material, such as that presented originally by Bridgman or by Mott and Jones, is given in more detail than in the original. This has been done in an attempt to provide a simple and self-consistent presentation.

References have been provided so that additional information can acquired by recourse to a minimum number of reliable sources.

The work will be of use to metallurgists and physicists. It details hc thermoelectric properties can reflect the influence of factors such as comp sition and cold work on the behavior of the solid state. Descriptions su as these can be useful in the design of alloys for purposes other th thermoelectric ones.

D. D. Pollo

Buffalo, N.Y.
February 1971

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The efforts of Mr. R. H. Cherry and Mr. D. I. Finch of the Leeds and Northrup Company are acknowledged with sincere thanks.

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Electrical Properties. Electrical Properties.Â Thermocouples are commonly used in a wide range of applications. Due to their wide range of models and technical specifications, but it is extremely important to understand its basic structure, functionality, ranges as to better determine the right thermocouple type and material of thermocouple for an application. What are the elements of a common thermocouple design?Â The output of a thermocouple depends on the type of thermocouple it is. The normal thermocouple categories include Types J, K, T, E and N which are called â€œBase Metalâ€ thermocouples, Types R, S and B which are called the â€œNoble Metalâ€ thermocouples, and Types C and D which are called the â€œRefractory Metalâ€ thermocouples.