improbable on theoretical grounds,[8] but it is difficult to rule out low-level luminescence on this basis alone.

A second explanation involves oxidation or reduction of impurities in the system, followed by homogeneous chemiluminescent electron-transfer reactions. However, it is still necessary to invoke either triplets or some energy-doubling process in order to account for the energy discrepancy.

This type of impurity mechanism was shown to be responsible for a major fraction of the pre-annihilation luminescence of the rubrene anion by the following experiments. In a 1.7×10^{-3} *M* solution of rubrene in DMF, 0.1 *M* in TBAP, the radical anion ($R\cdot^-$) was generated at constant potential until a slight excess of $R\cdot^-$ was present in the bulk of the solution (as indicated by a persistent green color and by the voltammetry of the solution). Thus, impurities which react with $R\cdot^-$ were essentially purged by titration with $R\cdot^-$. The coulombs passed to reach the end point represent an impurity level of 10^{-4} to 10^{-3} equiv/l. When the voltammetry of a freshly titrated solution was examined, an oxidation process commencing at -0.2 v and extending to the cation formation region was clearly evident. Furthermore, when the potential of the electrode was maintained in this region, light could be detected continuously (solution stirred) with no switching of the voltage required. No such oxidation process or light emission could be detected prior to the purging titration. After the solutions aged (20 min), both the oxidation process and the light emission disappeared. Further generation of anion failed to revive either one.

Clearly the rubrene radical anion reacts with some impurity (perhaps H_2O) to produce a moderately unstable decomposition product which, when oxidized, produces a chemiluminescent reaction.[9] Whether this chemiluminescent reaction necessarily involves traces of $R\cdot^-$ is difficult to determine, but it is known that the decomposition of the rubrene cation yields low levels of light in the absence of $R\cdot^-$.[10] A similar purging experiment with the cation was impossible owing to the intrinsic instability of this species.

The purged and aged solutions exhibiting anion lifetimes of many minutes (at least 20) and exhibiting no continuous luminescence in the -0.2 to $+0.9$-v region were also examined by a double-potential-step experiment. Apparent luminescent oxidation of the anion was still detected. However, the threshold voltage was shifted from -0.2 to $+0.5$ v *vs.* the sce. The intensity of the luminescence was about two orders of magnitude below the intensity produced by the annihilation reaction. It resembles the pre-annihilation light observed for cation reduction both in intensity and in overvoltage required and is only observed in a double-pulse or ac experiment while substantial anion oxidation current is passing. Although the mechanism of this residual luminescent process remains unproven, it may be due to direct generation of the triplet in a heterogeneous electron-transfer step.

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(8) R. A. Marcus, *J. Chem. Phys.*, **43**, 2654 (1965).

(9) The alternative explanation that the rubrene anion simply reduces an impurity to produce the species being oxidized is considered less likely in view of the lack of electrochemical evidence for the presence of any species more reducible than R.

(10) M. Hercules, R. C. Lansbury, and D. K. Roe, *J. Am. Chem. Soc.*, **88**, 4578 (1966).

Donald L. Maricle, Arthur Maurer
American Cyanamid Company, Research Service Department
Central Research Division, Stamford, Connecticut

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Book Reviews

Thermoanalytical Methods of Investigation. By PAUL D. GARN, Department of Chemistry, The University of Akron, Akron, Ohio. Academic Press Inc., 111 Fifth Ave., New York, N. Y. 1965. xvi + 606 pp. 16 × 23.5 cm. $19.50.

The chapters of the book are headed: "Changes in State on Heating"; "Differential Thermal Analysis"; "Evaluation of Differential Thermal Analysis Curves"; "Kinetics"; "Atmosphere Control"; "Special Techniques"; "Thermogravimetric Analysis"; "Thermogravimetric Apparatus"; "Simultaneous Measurements"; "Other Techniques"; "Miscellaneous Topics"; "Analysis of Gaseous Products"; "Recording, Control, and Power Equipment"; "Miscellaneous Apparatus and Information"; and "Apparatus Design". Appendices are added listing manufacturers of commercial equipment for differential thermal analysis, thermogravimetric analysis, and dilatometry; thermocouple emf's and enthalpic changes for a number of selected materials; and questions to be answered by prospective users to assist in equipment selection. An extensive bibliography is employed for documentation. As is evident from the chapter headings, the book essentially is devoted to differential thermal analysis and thermogravimetric analysis. However, as the author indicates, most of the parameters discussed under these two techniques are applicable to the other methods. Chapter 12, "Other Techniques," includes brief sections on dilatometry, electrical measurements, X-ray diffraction, thermomicroscopy, thermal conductivity, and calorimetry. Under "Miscellaneous Topics," the author presents brief coverage of polymers, mechanical effects in polymers "integral procedural decomposition temperature," dolomite and siderite decompositions, study of metathetical reactions at elevated temperatures, clay minerals as a continuous series, biological studies, fractional thermogravimetric analysis, detection of formation of compounds, and qualitative identifications. "Analysis of Gaseous Decomposition Products," Chapter 14, incorporates the author's personal experience in effluent gas analysis by the usual thermal conductivity technique, as well as by means of gas density measurement and gas chromatography. Mass spectrometry and the emanation method are also discussed.

The reviewer was disappointed in the arrangement of the text. This appears to be partly the fault of the publisher and partly that of the author. In any event, there appeared to be an excessive need to refer to other pages of the text for figures and for complete discussions of specific points.

A remarkable feature of the book is the interjection of the author's critical comments with respect to the significance of previous investigations in the field. These comments, based on the extensive experience of the author, are unique and add significantly to the value of the book. Typical of such comments is that recommending the utilization of other techniques for acquisition of kinetic data following 26 pages of discussion of the subject.

The sections on instrumentation are particularly well done, providing the reader with the advantages and limitations of system

components so that selection can be related to the work to be accomplished. The reviewer was surprised at the relatively small coverage given to applications to polymeric materials and the virtual omission of differential calorimetry. However, the orientation of the book is more theoretical than practical. Accordingly, the volume will be of continuing value to the experienced investigator in the field, as well as the novice.

C. B. Murphy
Xerox Corporation
Webster, New York 14580

The Molecular Basis of Heredity. By A. R. PEACOCKE, M.A. D.Sc., Lecturer in Biochemistry, University of Oxford, and Fellow of St. Peter's College, Oxford, and R. B. DRYSDALE, B.Sc., Lecturer in Microbiology, the University of Birmingham. Butterworth Inc., 7235 Wisconsin Ave., Washington, D. C. 1965. viii + 180 pp. 14 × 22 cm. $7.25.

The field of molecular biology has progressed rapidly since the Watson–Crick helical DNA structure was proposed a little more than a decade ago. A major advance during recent years has been the identification of DNA as the genetic material and the elucidation of the molecular mechanism by which genes direct the synthesis of proteins in the cell. The foremost discovery was messenger RNA and the identification of the ribosome as the site for protein synthesis. This led subsequently to the isolation and characterization of transfer RNA and to the deciphering of the genetic code.

The purpose of this book is to provide the advanced undergraduate and beginning graduate student with a broad survey of past and current literature in the field of molecular biology. The authors begin by tracing the chemical and genetic evidence which indicated the importance of the nucleic acids in heredity. This is followed by a section describing the structures of DNA, RNA, and nucleoproteins, and chromosomal structure. The remaining half of the book is concerned with the relationship between structure and function of the nucleic acids, describing the literature on replication of DNA, the chemical modification of DNA and its relationship to mutagenesis, colinearity of the gene and the polypeptide chain, biological regulatory mechanisms, protein synthesis, and the genetic code.

There have been a large number of major advances in the field since this book was written. Khorana and his colleagues have succeeded in synthesizing sequence specific long-chain polynucleotides and have almost completely determined the coding properties of all 64 triplet codons. Extensive new information has emerged concerning the biochemical nature of suppression, a phenomenon whereby one mutation can "suppress" the effect of a second distal mutation. This has provided insight into the mechanism of chain termination and chain initiation in protein synthesis, and has led to a deeper understanding of the biochemistry of polar mutations. Finally the mechanism of lysogeny, *i.e.*, how a virus integrates into the bacterial host chromosome, has been shown to involve an intermediate circular form of the viral genome, and this has been a major advance in bacteriophage genetics.

To be of significant value therefore, this book must be revised to include these and other recent advances in this field. In its present form, the book will be of only limited value to the advanced undergraduate and beginning graduate student in molecular biology.

H. M. Sobell
University of Rochester
Rochester, New York 14627

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