Graphite Intercalation Compounds: Progress of Research in Japan

Edited by S. Tanuma and H. Kamimura

(*World Science, 1985*)

During a two-year period beginning in April 1981, Japanese research on graphite intercalation compounds was organized into a "Special Distinguished Research Project" under the auspices of the Ministry of Education, Science and Culture. This functioned as an overlay to the already strong previous and continuing individual programs; more importantly, it provided support which launched many young scholars, some of whom have become major figures in the field. This book is the summary report of that two-year project. It will be of most interest to materials physicists working on graphite and other layer intercalates. There is also much of value for materials scientists in general, as an example of how different approaches, theoretical and experimental, are effectively coordinated. Industrial research managers and government program officers concerned about distinctions between "thrust areas" and individual projects will also find food for thought.

The book contains 37 articles, many of which have appeared elsewhere in longer or shorter versions. They are organized into seven chapters, each with a brief introduction and summary by the editors or other experts. The emphasis is overwhelmingly on basic physics. Electronic properties, a primary focus in Japan from the beginning, account for 40% of this volume. Another 30% is devoted to structural phase transitions and magnetism, topics that have attracted the interest of talented young researchers. Shorter chapters on carbon-13 NMR and chemical reactivity complete the presentation. Several articles document the problem, still unresolved, of reaching convergence between theory and experiment on the band structure of simple prototype compounds. Twelve papers are devoted to aspects of metal physics—quantum oscillatory phenomena, superconductivity, NMR, energy loss, etc.—many of which gave inconclusive results but will be important for those considering taking up these problems anew. The first two chapters, on phase diagrams and structural transitions, are a preview of the work which followed in 1984-1986. The book was clearly not intended as a materials science treatise; notably lacking are papers on defect morphology, electron microscopy, chemical synthesis etc. The project predates the Japanese discovery of high-quality graphite fibers via CVD, so the current work on intercalated fibers is not represented here.

The editors have done an excellent job assembling the book. The usual look of a progress report is avoided by extensive cross-referencing, and the summaries provide a critical flavor missing from conference proceedings. On the other hand, a more up-to-date picture of intercalated graphite research, Japanese and worldwide, is found in the proceedings of the 4th International Conference (May 1985, held in Tsukuba) which appeared as Volume 12 of *Synthetic Metals.* This latter volume contains important new results on angle-resolved photoemission, synchrotron x-ray scattering, theories of staging transition kinetics, neutron scattering studies of magnetic structures and phase transitions, synthesis of novel compounds with alternating magnetic and nonmagnetic, donor and acceptor intercalate layers, ternary compounds containing hydrogen, and fiber growth and intercalation—all by yet another cohort of young Japanese researchers. Even at twice the price, it would be the better choice in most cases. The volume under review does contain material not published elsewhere which will be important for newcomers, particularly those planning to try cyclotron resonance, magnetostriction, induced torque or helicon experiments. Considering the general reader on a longer time scale, its principle value is to demonstrate the effectiveness of a MITI-like approach to basic science, the best evidence of which is the dominance of Japanese research at the conference which took place two years after the project ended.

Reviewer: John E. Fischer is professor of materials science and electrical engineering at the University of Pennsylvania.

Viscoelasticity — Basic Theory and Applications to Concrete Structures

G.T. Creus

(*Springer-Verlag, 1986*)

The author has presented the basic theory of viscoelasticity and its application to time-dependent behavior of concrete in a concise, easy-to-read form. The arrangement and selection of material, along with numerous solved examples and computer listings, make it possible for a new student to understand the essential concepts quite clearly.

Chapter I deals with the basic concepts of viscoelastic behavior. Constitutive equations for a general material are derived, and special cases for elastic and viscoelastic materials are discussed. Creep and relaxation phenomena are introduced by showing experimental results. The concepts of linearity and aging are then explained, and the integral form of the constitutive equa-

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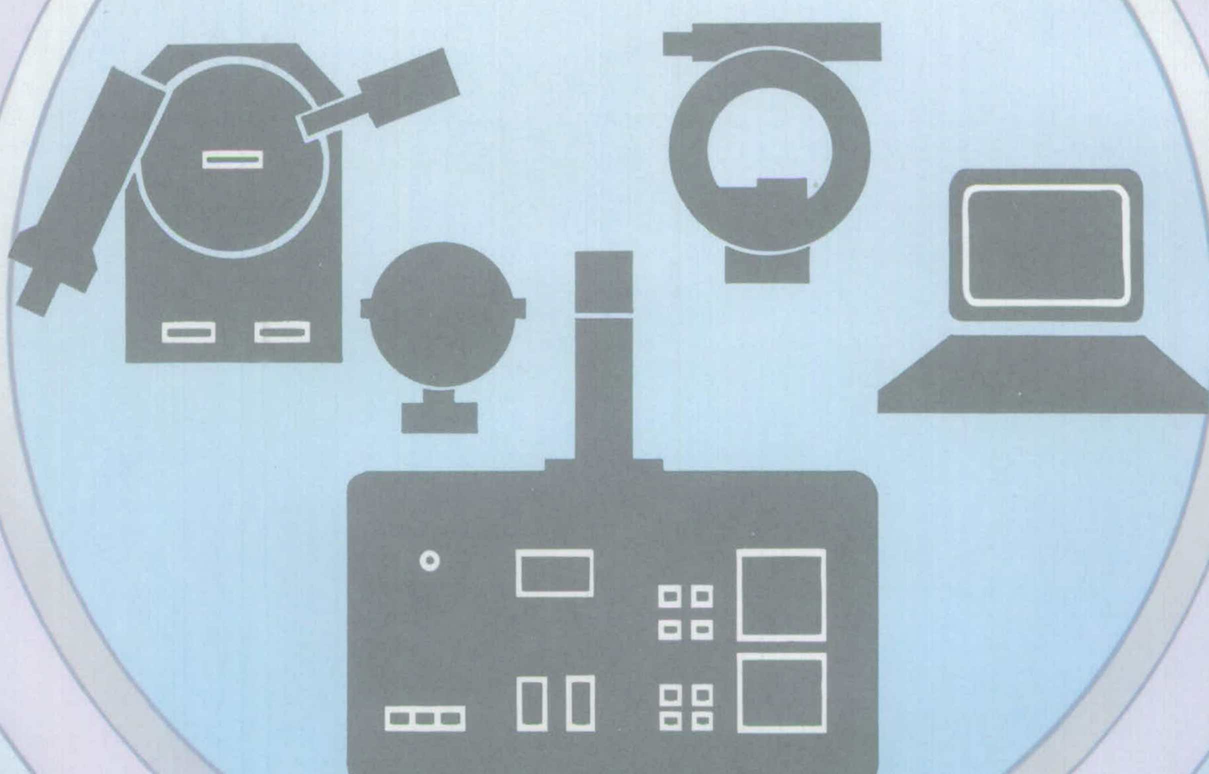

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https://doi.org/10.1557/S0883769400054063 Published online by Cambridge University Press

tion for linear aging viscoelastic materials is derived. Finally, a numerical solution for the integral equation is outlined, along with a program listing for this. Although it is indirectly explained in several parts of the chapter, a clear definition of viscoelasticity could be included at the beginning.

The use of rheological models, namely Kelvin and Maxwell models, is introduced in chapter II. Equations for creep and relaxation using these models are derived, and the concepts of relaxation time and retardation time are introduced by good illustrations. The need to use generalized models (chain of Kelvin and Maxwell models) is explained; equations for a standard Kelvin model (three-parameter system) are derived. Conversion of integral equations to a set of uncoupled differential equations is shown. A nonlinear Kelvin model is introduced at the end of the chapter.

In chapter 3, the response of the "standard" model to different loading conditions is discussed rather extensively. The concepts of stable viscoelastic materials and fading memory of non-aging materials are explained in this chapter. Finally, approximate solutions using reduced (effective) modulus are derived and several examples are worked out to illustrate the use of different moduli.

Chapter 4 extends the unidimensional theory discussed in previous chapters to three dimensions. Analogy is drawn with equations of elastic materials when formulating the relations for viscoelastic materials.

The theory of viscoelasticity which has been described in the first four chapters is applied to concrete and concrete structures in chapters 5 and 6. Chapter 5 starts with a good explanation of physical mechanisms of creep and shrinkage in concrete. The essential facts and definitions of creep and recovery are illustrated well in section 2. Some mathematical forms for expressing creep and shrinkage are introduced; practical forms of these expressions which are used in structural analysis, such as the Dischinger model and Bazant-Parrula model, are described. Finally, a brief review of code expressions and nonlinear viscoelasticity of concrete is given.

Chapter 6 deals with structural analysis methods of viscoelastic beams. Homogeneous and nonhomogeneous materials are considered. The flexibility method is employed in analysis and several examples are worked out. Approximate solutions using the reduced modulus method are derived. The chapter ends with a detailed example of stress redistribution in a reinforced concrete column; different solution techniques, using standard model and practical prediction formulas, are illustrated well in this example.

Analysis of viscoelastic materials using the finite element method (FEM) is introduced in chapter 7. The chapter starts with an excellent introduction to FEM; the use of FEM to solve truss elements is illustrated by means of some well-chosen solutions. The need to use rate-type equations when dealing with viscoelastic structures in FEM is explained and the corresponding formulas in 3-D are derived. An incremental approach to solve viscoelastic problems is described. A listing of FEM programs to solve viscoelastic trusses is given at the end of the chapter.

The concepts of stability and buckling as applied to viscoelastic structures are discussed in chapter 8. Following the practice of previous chapters, theory is introduced for elastic structures and then extended to viscoelastic cases. The chapter ends with a look at buckling of nonlinear viscoelastic structures and a brief review of code formulas.

Several reference listings given at the end of each chapter provide interested readers with a good source for further reading.

Though the style of the text is pleasing to the reader, the numerous grammatical and spelling errors could have been minimized. It also seems that too much theory and too little application has been included. In chapter 6, one of the main areas where time-dependent deformations of concrete structures are considered, the example given is for bridges (segmental and cantilever construction); more examples concerning this concept could have been included. A good knowledge of computer programming may be useful for solving certain examples in the book.

Reviewer: Dr. S.P. Shah is professor of civil engineering and director of the Center for Concrete and Geomaterials at Northwestern University, Evanston, IL.

Aerogels
Edited by J. Fricke

(Proceedings in Physics, Vol. 6, Springer-Verlag, 1986)

Aerogels remained a scientific curiosity for many years after their discovery more than 50 years ago. Recent increased interest, however, prompted the first International Symposium on Aerogels at Wurzburg in September 1985. This book contains the papers presented at that conference. The introduction by the editor, J. Fricke, is followed by the papers which are divided into four sections. These cover Production and General Aspects (eight papers), Energy Conservation and Thermal Properties (eight papers), Structural Aspects (five papers), and Applications (three papers).

For those not familiar with aerogels, the extensive introduction, aptly titled "Aerogels—a Fascinating Class of High-Performance Porous Solids," provides an excellent initiation. It also serves as a general overview for the more specific papers that follow. This introduction covers the history of aerogels: their discovery by Kistler in 1932; their preparation by supercritical drying, initially after solvent exchange from aqueous systems, and more recently from sol-gel materials; their properties; and some current applications.

The papers in the Production and General Aspects section illustrate the versatility of the supercritical drying process in that a large variety of gels can be converted to aerogels. These include multicomponent oxide, oxide-metal mixtures, and glass compositions in addition to silica, which is the most common.

Demand for silica aerogels in particular is such that a commercial operation has been set up by Henning in Lund, Sweden, and this is described. This demand was initiated by their particular suitability as Cerenkov counters, because of low refractive index; but commercial availability is now a large incentive for evaluation in a number of other applications.

Recently, the thermal properties of aerogels have become important for insulation applications. The section on Energy Conservation and Thermal Properties contains papers describing investigations of radiant heat transfer, thermal conductivity, and solar transmission all tied to potential use as super insulators. This seems to be a promising application but little mention is made of the cost, and this no doubt will be the major factor in future development.

The studies described in the Structural Aspects section were carried out on silica samples only. Electron micrographs showed extremely small particle size which correlated with the surface area, pore size and volume, and pore size distribution measurements. The optical transmission of thin sections and some mechanical and acoustic properties are also described.

Finally, the papers in the Applications section describe some of the noninsulative applications. Perhaps the most versatile use is in the catalyst field where the high surface area and variety of aerogel materials is of particular significance. Both fixed bed reactors with multicomponent oxides and fluidized beds with metal-metal oxide materials have been investigated with impressive results. Another interesting use was that of silica as a thickening agent for rather potent reagents such as red fuming nitric acid rocket fuel in addition to more mundane materials such as gasoline.

This book is highly recommended both as an introduction to aerogel science for the general reader and as a state-of-the-art review for those more familiar with the field.

Reviewer: Ian M. Thomas is a chemist at Lawrence Livermore National Laboratory, Livermore, CA.

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