

Article

Two-Dimensional Mechanical Behavior Analysis of Multilayered Solids Subjected to Surface Contact Loading Based on a Semi-Analytical Method

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Abstract: In this paper, a two-dimensional semi-analytical method is developed for the mechanical behavior analysis of multilayered solids subjected to surface contact loading, which is indispensable for realizing an optimized tribological performance from the mechanical behavior point of view. Firstly, the explicit analytical frequency response functions of the multilayered solid are derived in a recursive form by analytically solving a system of linear equations established according to the boundary conditions and the interface continuous conditions. Then, the two-dimensional elastic field solution in the subsurface of multilayered solids in the space domain is converted from its corresponding frequency response functions by employing a numerical conversion method based on the inverse fast Fourier transformation. The present method is validated by comparing with the solution given by other methods. Lastly, the stress analysis of multilayered coatings with various structure layouts and various layer number of the multilayers were performed with the present method.

Keywords: multilayer coatings; two-dimensional elastic field solution; analytical frequency response functions; numerical conversion method; mechanical behavior analysis

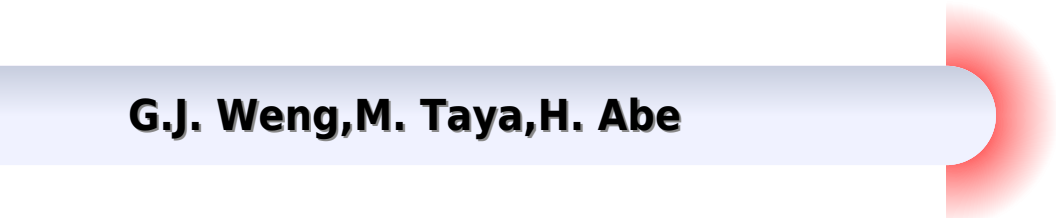
1. Introduction

With the progress of surface engineering in the past several decades, multilayer coatings are often used in the surface modification of tribo-parts to enhance their tribological performance and service life under extreme service conditions, such as high vacuum, high radiation, high load, and high temperature [1–4]. Meanwhile, from the mechanical behavior point of view, a deformation and stress analysis of multilayered solids is indispensable to their optimal design and engineering application [5].

Many researches have been carried out theoretically and numerically to understand the mechanical behavior of coated solids by using different methods. Besides the finite element method [6–9], boundary element method [10,11], and image point method [12–14], the integral transform techniques [15] were most popular in producing the elastic field solution of layered mediums. If the fundamental solutions that satisfy the governing equations are obtained with integral transform techniques or other methods, then a semi-analytical method or model, which always has a higher

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Micromechanics and Inhomogeneity G.J. Weng,M. Taya,H. Abe,2012-12-06 Toshio Mura has written extensively on micromechanics over the years and in part due to his writings and many others in the field micromechanics has gradually emerged as a recognized discipline in the study of mechanics of materials The idea is to bring both the mechanics and physics on the micro scopic level to the macroscopic scale so that the deformation and fracture processes of materials can be better understood While much apparently remains to be done this approach has already shed new light on certain selected topics and has proved to be fruitful It is indeed a happy occasion to celebrate both Toshio s upcoming 65th birthday and the emergence of this young science at the same time The volume contains thirty seven original articles on the related topics of micromechanics and inhomogeneity it is presented to Toshio by his friends colleagues and admirers as a wish for his good health and continuing pro ductivity The contributors belong to both the applied mechanics and the materials communities all with a common belief that micromechanics is an indispensable area of research It is hoped that this somewhat balanced structure will make the volume more useful to a wider range of readers and that in the meantime it will still reflect more or less the spectrum of Toshio s lifelong works As Editors we have at the outset set the highest possible standards for the book with a keen anticipation that the volume will be widely circulated for many years to come **Mechanical Properties of**

Solid Polymers Ian M. Ward,John Sweeney,2012-10-22 Providing an updated and comprehensive account of the properties of solid polymers the book covers all aspects of mechanical behaviour This includes finite elastic behavior linear viscoelasticity and mechanical relaxations mechanical anisotropy non linear viscoelasticity yield behavior and fracture New to this edition is coverage of polymer nanocomposites and molecular interpretations of yield e g Bowden Young and Argon The book begins by focusing on the structure of polymers including their chemical composition and physical structure It goes on to discuss the mechanical properties and behaviour of polymers the statistical molecular theories of the rubber like state and describes aspects of linear viscoelastic behaviour its measurement and experimental studies Later chapters cover composites and experimental behaviour relaxation transitions stress and yielding The book concludes with a discussion of breaking phenomena

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Classical And Computational Solid Mechanics Pin Tong, 2001-06-29 This invaluable book has been written for engineers and engineering scientists in a style that is readable precise concise and practical It gives first priority to the formulation of problems presenting the classical results as the gold standard and the numerical approach as a tool for obtaining solutions The classical part is a revision of the well known text Foundations of Solid Mechanics with a much expanded discussion on the theories of plasticity and large elastic deformation with finite strains The computational part is all new and is aimed at solving many major linear and nonlinear boundary value problems Computational Methods in Nonlinear Structural and Solid Mechanics Ahmed K. Noor, Harvey G. McComb, 2014-05-20 Computational Methods in Nonlinear Structural and Solid Mechanics covers the proceedings of the Symposium on Computational Methods in Nonlinear Structural and Solid Mechanics The book covers the development of efficient discretization approaches advanced numerical methods improved programming techniques and applications of these developments to nonlinear analysis of structures and solids The chapters of the text are organized into 10 parts according to the issue they tackle The first part deals with nonlinear mathematical theories and formulation aspects while the second part covers computational strategies for nonlinear programs Part 3 deals with time integration and numerical solution of nonlinear algebraic equations while Part 4 discusses material characterization and nonlinear fracture mechanics and Part 5 tackles nonlinear interaction problems The sixth part discusses seismic response and nonlinear analysis of concrete structure and the seventh part tackles nonlinear problems for nuclear reactors Part 8 covers crash dynamics and impact problems while Part 9 deals with nonlinear problems of fibrous composites and advanced nonlinear applications The last part discusses computerized symbolic manipulation and nonlinear analysis software systems The book will be of great interest to numerical analysts computer scientists structural engineers and other professionals concerned with nonlinear structural and solid mechanics *AFOSR Research: the Current Research Program, and a Summary of Research Accomplishments* United States. Air Force. Office of Scientific Research, 1967 This report is designed to present the research programs of the Air Force Office of Scientific Research for the information of users of Air Force research for scientific investigators working in the same or in allied fields and for the military scientific and academic and Government communities at large *Solid State Ionics: Trends In The New Millennium, Proceedings Of The*

8th Asian Conference B V R Chowdari, S R Sahaya Prabakaran, M Yahaya, I A Talib, 2002-12-04 This volume presents a comprehensive collection of state of the art advances in the field of solid state ionic materials and the design fabrication and performance of devices that use them such as lithium batteries gas sensors fuel cells supercapacitors and electrochromic displays These electrochemical devices are becoming pervasive in our technologically driven lifestyles The book includes research activities being carried out in the new millennium through special keynote addresses as well as invited and contributed papers related to experimental and theoretical modeling in solid state ionics The excellent coverage of topics arranged in such a fashion helps students and beginners to understand the field with enthusiasm It also encompasses various experimental techniques often employed in solid state ionics research such as XRD XPS hole burning spectroscopy EDAX EXAFS SEM thermal analysis techniques ac impedance spectroscopy and other electrochemical techniques such as cyclic voltammetry galvanostatic and potentiostatic electrochemical techniques Theoretical and applied aspects of mixed conduction for applications mainly in solid oxide fuel cells occupy a portion of the text Finally this volume demonstrates the amount of research activities being carried out in this application oriented field Solid State Ionics will be of interest to all in the solid state ionics community including chemists physicists materials scientists and electrochemists both in industry and in research Energy Research Abstracts, 1988 Technical Abstract Bulletin Defense Documentation Center (U.S.), 1964

IUTAM Symposium on Synthesis in Bio Solid Mechanics Pauli Pedersen, Martin P. Bendsøe, 2006-04-11 This book contains the edited version of invited lectures presented at the IUTAM Symposium Synthesis in Bio Solid Mechanics held at Hotel Frederiksdal Virum Copenhagen Denmark May 24 to May 27 1998 The symposium was attended by 48 scientists from 14 countries Biomechanics has been a very active research area in the last 25 years and covers a very broad class of problems The present symposium concentrated on the solid mechanics main of biomechanics where important problems of synthesis presently are an active and challenging part Characteristics of biomechanical materials are not only the inhomogeneity and anisotropy but also the capability to change in relation to actual use These living materials call for new methods of analysis and also new methods for synthesis By the synthesis in this context is meant design of implants or artificial control of material growth Bone mechanics is closely related to recent work on analysis and design of microstructural anisotropic materials Also recent work in shape design can to some extent be useful in the more complicated problems of biomechanics Here interface problems play an essential role The symposium brought together scientists from mechanics mathematics and medicine **Mechanical Behaviour of Materials** Dominique François, André Pineau, André Zaoui, 2013-03-09 Designing new structural materials extending lifetimes and guarding against fracture in service are among the preoccupations of engineers and to deal with these they need to have command of the mechanics of material behaviour The first volume of this two volume work deals with elastic and elastoplastic behaviour this second volume continues with viscoelasticity damage fracture resistance to cracking and contact mechanics As in Volume I the treatment starts from the

active mechanisms on the microscopic scale and develops the laws of macroscopic behaviour Chapter I deals with viscoplastic behaviour as shown for example at low temperatures by the effects of oscillatory loads and at high temperatures by creep under steady load Chapter 2 treats damage phenomena encountered in all materials for example metals polymers glasses concretes such as cavitation fatigue and stress corrosion cracking Chapter 3 treats those concepts of fracture mechanics that are needed for the understanding of resistance to cracking and Chapter 4 completes the volume with a survey of the main concepts of contact mechanics As with Volume I each chapter has a set of exercises either with solutions or with indications of how to attack the problem and there are many explanatory diagrams and other illustrations

Scientific and Technical Aerospace Reports ,1991 **Recent Research Advances on Heavy Metals, Microplastics, Persistent Organic Pollutants, and Solid Waste in Aquatic and Terrestrial Ecosystems** Zhenming Zhang,Baile Xu,Xuetao Guo,Yaoguang Guo,2024-03-25 *Mechanical Behavior of Crystalline Solids* ,1963 **Polymer-based Solid State Batteries** Daniel Brandell,Jonas Mindemark,Guiomar Hernández,2021-07-19 Recent years has seen a tremendous growth in interest for solid state batteries based on polymer electrolytes with advantages of higher safety energy density and ease of processing The book explains which polymer properties guide the performance of the solid state device and how these properties are best determined It is an excellent guide for students newcomers and experts in the area of solid polymer electrolytes **Phosphates—Advances in Research and Application: 2012 Edition** ,2012-12-26 Phosphates Advances in Research and Application 2012 Edition is a ScholarlyEditions eBook that delivers timely authoritative and comprehensive information about Phosphates The editors have built Phosphates Advances in Research and Application 2012 Edition on the vast information databases of ScholarlyNews You can expect the information about Phosphates in this eBook to be deeper than what you can access anywhere else as well as consistently reliable authoritative informed and relevant The content of Phosphates Advances in Research and Application 2012 Edition has been produced by the world s leading scientists engineers analysts research institutions and companies All of the content is from peer reviewed sources and all of it is written assembled and edited by the editors at ScholarlyEditions and available exclusively from us You now have a source you can cite with authority confidence and credibility More information is available at <http://www.ScholarlyEditions.com>

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