

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

Recent Research On Mechanical Behavior Of Solids

Chao Zhang

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