Developing Linear Viscoelastic Constitutive Models of Epoxy with Nano Particles from Compression Test Data by Using Inverse Finite Element Analyses

N.-S. Liou[1] **and M.-C Chuang**[2]

Abstract: The objective of this study was to examine the time dependent mechanical properties of cold mounting epoxy with TiO2 nano particles under compression condition and to identify material parameters for the easy-to-use constitutive equation which can describe the time dependent mechanical response for finite element analyses. Cold mounting epoxies used to encapsulate samples are frequently used as the matrix materials for fracture tests of small size biological materials and the characterization of fracture parameters of these small size biological specimens are usual carried out by using finite element simulations. In order to perform high fidelity finite element simulation to identify the fracture properties of embedded biological specimens, the proper mechanical properties of matrix material should be used in the FE analyses. The ramp-hold compression tests with different ramping strain rates (10^{-2} and $10^{-1}\ s^{-1}$) were performed to investigate the time dependent mechanical response of the cold mounting epoxy with TiO2 nano particles. In this study, epoxies were considered as linear viscoelastic materials and the viscoelastic material parameters of a cold mounting epoxy with TiO2 nano particles used as matrix material for fracture tests of hard biological tissues were identified by using inverse iterative finite element procedure from compression test results. The generalized pattern search method was used for the optimization process. The generalized pattern search method is a direct search derivative-free algorithm which can minimize an objective function with respect to the unknown parameters. The time dependent parameters of the aforementioned eopxy were determined by minimizing the least squared error between the simulated and experimental stress of ramp-hold compression tests with different compression rates. The results showed that the linear viscoelastic constitutive model with three viscoelastic time constants can well describe the mechanical behavior of cold mounting epoxy with TiO2 nano particles.

[1,2] Department of Mechanical Engineering
Southern Taiwan University
1 Nan-Tai Street, Yongkang Dist., Tainan City 710, Taiwan

[1] *nliou@mail.stut.edu.tw*

[2] *49614016@stut.edu.tw*