Journal of Applied Mechanics Book Reviews

Thermomechanical Coupling in Solids, edited by H. D. Bui and Q. S. Nguyen. IUTAM, North-Holland, Amsterdam, 1987.

REVIEWED BY T. MURA[1]

This IUTAM Symposium, dedicated to the memory of Jean Mandel, was held in the first week of September 1986, covering topics: thermodynamics of irreversible process, dissipative phenomena in plasticity and viscoplasticity in fracture and damage, behaviors of heterogeneous or complex media such as composites, woods and geomaterials, phase transformation, experimental techniques based on infrared thermography, cyclic leads, large deformation, numerical methods for coupled problems, etc. The topics are heterogeneous but unified in terms of thermomechanical couplings.

Some of the papers presented in this proceeding will be briefly reviewed here.

I. Müller simulated thermomechanical properties of materials with shape memory and proposed a model with the potential energy under a shear load and interfacial energy. Statistical mechanics of the model is discussed.

J. Kestin presented his recent work on metal plasticity as a problem in thermodynamics. He is interested in the fact that Volterra and Somigliana dislocations can be produced by fictitiously reversible processes of changing the internal state created by plastic deformation. In turn, this makes it possible to calculate entropy and Gibbs equations.

G. J. Dvorak's paper is "Thermomechanical deformation and coupling in elastic-plastic composite materials." He presented his recent discovery that spatially uniform stress and strain fields can be caused in certain heterogeneous media by simultaneous application of a uniform thermal change and uniform overall stress.

J. L. Lataillade presented the use of a standard infrared camera to measure the temperature evolution of a polymetric material during its dynamic plastic deformation.

M. P. Luong used infrared vibrothermography as a nondestructive technique to analyze the unstable crack propagation in concrete.

J. R. Barber and M. Comninou reviewed thermoelastic effects in fracture and discussed crack closure and thermal contact resistance.

P. Perzyna's paper concerns the influence of thermomechanical coupling on dynamic fracture of ductile solids.

M. Taya and T. Mori used the Eshelby method to evaluate dimensional change in metal matrix composites subjected to thermal cycling. At high temperature, the thermal stress relaxation occurs by first matrix creep and followed by the diffusion around the matrix-fiber interfaces. At low temperature, the thermal stress relaxation occurs by plastic deformation in the matrix. The theory is satisfactory with experimental measurements of the dimensional change.

F. D. Fisher et al. also investigated thermal cycling of hangers theoretically and experimentally. They found "unexpected phenomena" that this cyclic temperature loading leads to failure of the hangers by large cracks initiated internally, which differs from the chill cracks in casting dies, etc.

A. C. F. Locks and F. A. Leckie presented an internal state variable theory for the tertiary stage of creep responsible for the degradiation of the material.

J. B. Leblond et al. studied the anomalous plastic behavior of steels during phase transformations by using the Hill-Mandel theory and by the finite element method.

T. Inoue, Z. G. Wang and K. Miyao investigated the role of transformation plasticity in the carburized quenching process.

T. H. Lehmann presented thermomechanical coupling in large deformations particularly in bifurcation problems.

H. D. Bui, A. Ehrlacher, and Q. S. Nguyen studied the thermal effect due to thermomechanical coupling at the tip of a moving crack within the framework of classical thermodynamics. The crack tip is a heat source and its temperature singularity is discussed. The results are compared to experimental observations by infrared thermography.

C. Theodosiu gave an analysis of a set of viscoplastic constitutive equations for metals and alloys in the hot working range. The initial and boundary-value problems are solved by the 2-D finite element method for plane and axisymmetric viscoplasticity with consideration of thermal boundary conditions. The results are compared with experimental data.

A. R. S. Ponter and J. A. Scaife explored properties of a class of constitutive equations which model the high temperature creep of metals.

A First Look at Perturbation Theory, by James G. Simmonds and James E. Mann, Jr., Robert E. Krieger Publishing Company, Malabar, Florida, 1986. 144 Pages. $12.50.

REVIEWED BY J. LYELL SANDERS, JR.[2]

This small 136-page monograph is an excellent introduction to the subject for anyone who knows calculus through the level of an undergraduate course on ordinary differential equations. Some proofs are offered, but the emphasis is always on understanding rather than rigor. There are ample references to the literature for more in-depth treatment of a particular topic.

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