
**04-6 IUTAM Symposium on Mechanics and Reliability of Actuating Materials
Beijing, China, September 01-03, 2004**

a) Scientific Committee

W. Yang (Chair-China), D. Gross (Germany), Y.W. Mai (Australia), R.M. McMeeking (USA), Z. Suo (USA), K. Watanabe (Japan), F. Ziegler (Austria), J. Salençon (France, IUTAM Representative).

b) Short summary of scientific progress achieved

The main themes of the symposium are: Actuating materials hold a promise for fast-spreading applications in smart structures and active control systems, and have attracted extensive attention from scientists of both mechanics and materials sciences communities. High performance and stability of actuating materials and structures play a decisive role in their successive applications as sensors and actuators in structural control and robotics. Toward this end, scientific efforts are of paramount significance to gain a deep insight into the intricate deformation and failure behaviors of actuating materials. Examples worthy of intensive exploration are: (i) the constitutive relations of actuating materials that couple mechanical, electrical, thermal and magnetic properties, as well as incorporate phase transformation and domain switch; (ii) the physical mechanisms of deformation, damage, and fatigue crack growth of actuating materials; (iii) the development of failure-resilient approaches that base on the macro-, meso-, and micro-mechanics analyses; (iv) the investigation of microstructural evolution, stability of phase transformation, and size effects of ferroelectric ceramics, shape memory alloys and actuating polymers. The above problems represent an exciting challenge and form a research thrust of both materials science and solid mechanics. The main aim of this symposium was to assemble top scientists working in the actuating materials to exchange their scientific results and ideas and thereby to further their collaboration in the coming years.

The symposium records the following scientific progresses in the topical area:

1. Various novel methods to measure domain switching zone are proposed. Interrelation between fracture and fatigue with domain switching is confirmed experimentally.
2. The importance of discharge and electric boundary condition is recognized through experiment and theory. An interesting model of charge free zone (CFZ), similar to dislocation free zone for the mechanical case, drawn large attention of the participants.
3. Interaction between domain switching and defect agglomeration is emphasized, the framework of configurational forces and microstructural evolution is under rapid development.
4. Multi-scale constitutive modeling of piezo/ferro/magneto-electric materials gains headways, as addressed through several presentations from different aspects.
5. Numerical schemes for actuating materials is near to the verge of commercial development.

6. Optimal design to maximize the performance of actuating materials in smart structures becomes important, and several ways to accomplish this goal is proposed.
7. Actuating of piezoelectric cylinders, a typical configuration in MEMS.
8. Dynamics and non-destructive detection of actuating materials.
9. Multi-axes testing of ferroelectric ceramics and single crystals.
10. Transformation spirals in nano-grained microtubes, both experiments and numerical simulation verify this new phenomenon.
11. Accumulated experimental data and theoretical framework for biologically actuating materials (such as hearts) and bio-films.

c) Countries represented and number of participants

There were total of 35 invited participants plus about 20 graduate students and postdocs from China to attend the symposium. The geographic distributions of the participants are: Australia (2), Canada (1), China mainland (15), Germany (7), Hong Kong, China (2), Japan (5), UK (2) and USA (1).

d) Publication of Proceedings of the Symposium

A contract for the publication of the symposium proceedings was signed by Springer Science and Business Media (former Kluwer Academic Publishers) and Prof. W. Yang.

e) Financial supports

The symposium was sponsored by the International Union of Theoretical and Applied Mechanics.

f) Scientific program

September 1, 2004

H. Kessler, P. Bürmann and H. Balke, *A switching rule for local domain wall motions and for the macroscopic material response of ferroelectrics*

D.N. Fang and F.X. Li, *The effects of sieving method and poling approach on the internal bias field in donor doped PZT ceramics*

D. Gross and R. Mueller, *Interaction between defects and domain walls in piezoelectric materials*

F. Fang, W. Yang, F. C Zhang, H. S. Luo, *In-situ observation of electrically induced fatigue crack growth for ferroelectric single crystals*

Naotake Noda, Cun-Fa Gao, *Effect of electric fields on fracture of functionally graded piezoelectric materials*

Jürgen Rödel, Alain B. Nijwa Kouna and Doru Lupascu, *Ferroelastic toughening in PZT*

Tong-Yi Zhang, *The charge-free zone model for conductive cracks in dielectric and piezoelectric ceramics*

Y. H. Chen and Z.C. Ou, *Electric potential drop across a crack in piezoelectrics*

H. Berger, S. Kari, N. Bohn, R. Rodriguez and **U. Gabbert**, *A micro-macro approach to design active piezoelectric fiber composites*

Zhen-Bang Kuang, *Quan Jiang*, *Stress analysis in two dimensional electrostrictive material under general loading*

Batra, R.C.,

September 2, 2004

Bin Gu, **Shou-Wen Yu**, Xi-Qiao Feng, *Elastic Sv-wave scattering by an interface crack between a piezoelectric layer and an elastic substrate*

Kuna, Meinhard, *FEM-techniques for thermo-electro-mechanical analyses in smart structures*

Qing-Hua Qin, *Treffitz plane element of piezoelectric plate with p-extension capabilities*

Y. Chen and **R.K.N.D. Rajapakse**, *Electric charge loading of a piezoelectric solid cylinder*

I. Westram, D.C. Lupascu and J. Rödel, *Crack initiation and crack propagation under cyclic electric loading in PZT*

Sven Lentzen and **Rüdiger Schmidt**, *On piezoelectric actuatorlayers in plates and shells at large deflection*

Kazumi Watanabe, *Stress Analysis for an Anisotropic Solid with Variable Off-Axis of Anisotropy*

Qian Wan, **Changqing Chen**, and Yapeng Shen, *Electromechanical behavior of relaxor ferroelectric single crystal (PMN-32PT) and polycrystalline ceramics (PZT5)*

M. Urago, F. Jin, Y. Mochimaru and K. Kishimoto, *Oblique propagation of time harmonic waves in periodic piezoelectric composite layered structures*

S. Hao, B. Moran, D. Chopp, *Biofilm growth: perspectives on two-phase mixture flow and fingerings formation*

F. Jin, K. Kishimoto, Z. Qian and Z. Wang, *Scattering behaviour of elastic waves in 1-3 piezoelectric ceramic/polymer composites*

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Qing-Ping, Sun, *Pattern formation and evolution in NiTi shape memory alloy microtubing*

Wenyi Yan and Yiu-Wing Mai, *Theoretical consideration on the fracture of shape memory alloys*

L.H. Han and **T.J. Lu**, *3D finite element simulation for shape memory alloys*

Xiao-Jing Zheng, Xin-En Liu, *Constitutive Models for Magnetostrictive Materials*

Z. Zhong and Y. P. Wan, *Vibration analysis of a nonlinear magnetostrictive actuator*

G.-X. Ren, *Test study of feed-support of very large radio telescope*

Biao Wang, C. H. Woo, and Yue Zheng, *Stability analysis of 180o domains in ferroelectric thin films*

X.M. Zhang, F. Yang, N.K. Ma and **W. Yang**, *Damage and fatigue of actuating heart muscles*

Report composed by Wei Yang