中国力学学会　　中国声学学会　　IEEE

第三届全国压电和声波理论及器件技术研讨会

The Third Symposium on Piezoelectricity, Acoustic Waves, and Device Applications

SPAWDA08

2008年12月5日－12月8日
December 5-8, 2008

南京航空航天大学
南　京　大　学　　联合承办
江苏省力学学会

第三届全国压电和声波理论及器件技术研讨会

The Third Symposium on Piezoelectricity, Acoustic Waves, and Device Applications

SPAWDA08

http://piezo.nbu.edu.cn/spawda08/

Dec. 5 - 8, 2008

中国 · 南京

Nanjing, China

欢 迎 词

欢迎大家来到六朝古都、历史名城 —— 南京！

在中国力学学会、中国声学学会、IEEE 等专业协会的支持下，“全国压电和声波理论及器件技术研讨会”至今已历三届。第一届会议于 2004 年 12 月 14-17 日在宁波大学召开，共有 142 人与会；第二届会议于 2006 年 12 月 14-17 日在浙江大学召开，参会人员 148 人。这两届会议呈现出几大特色，其一是会议代表具有广泛性，分别来自于高校、研究机构和产业界，为理论研究和实际技术的结合创造了良好的条件；其二是，尽管定位于全国会议，但每届都有 20 名左右来自境外（包括美国、欧洲、日本、香港、台湾、埃及和沙特阿拉伯）的代表，他们的参与为会议带来了新的理论研究成果和研究方向及介绍了产业技术发展的新态势，推动了国际学术交流和技术合作；其三是采取各种措施（如注册费减半等）鼓励学生参会，第一届和第二届分别约有 20 名和 30 名学生在会上作了学术报告，促进了后备力量的成长。事实上，参加过前两届会议的一些学生已经成为这一领域引人注目的新生研究力量。

第三届会议于 2008 年 12 月 5—8 日在江苏省南京市举行，由南京航空航天大学、南京大学和江苏省力学学会承办。从投稿摘要和注册代表情况看，以上三个特色不仅继续得到保持，而且明显地发扬广大，这正是这一系列会议的最大目标。作为会议组织者，我们特别希望，除了会上的交流以外，学校和其它科研机构之间、研究者和技术人员之间、力学研究者和声学研究者之间、国内和国外代表之间、资深代表和学生代表之间以及每位代表之间在会后能够作更深入的相互了解并促进双方甚至多方的进一步合作，使得理论和实践能够完美结合，促进相关科学和技术领域的发展。

本摘要集供各位代表开会时使用，也可供会后需要时查阅使用。会议论文集将以 IEEE 的名义出版，纳入 IEEE Xplore 数据库。

本次会议得到了南京航空航天大学、Vectron International、浙江东晶电子股份有限公司、北京长峰声表面波公司、无锡好达电子有限公司等多家单位的大力资助，在此表示衷心的感谢。另外，会议的筹备、组织工作也得到了宁波大学和浙江大学等多位老师和学生的帮助，在此一并表示感谢。

除了参与此次会议学术报告和交流之余，我们也希望各位代表能有时间去秦淮河、乌衣巷、夫子庙、莫愁湖等著名景点阅读历史、回味历史，不妨遐想当日王谢的风流和体味世事的沧桑，为我们繁忙的生活增添闲情雅趣。

衷心祝愿这次会议给您留下美好的记忆！

丁皓江

会议主席

2008 年 12 月

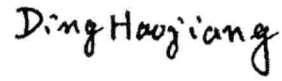
WELCOME

Welcome to Nanjing!

The Third Symposium of Piezoelectricity, Acoustic Waves, and Device Applications will be held in Nanjing University of Aeronautics and Astronautics (NUAA), Nanjing, from December 5-8. The success of the first SPAWDA 2004 in Ningbo and the second SPAWDA 2006 in Hangzhou has promoted us to organize this one to maintain the features of this unique conference series with strong international participation. We hope the joint support from universities, businesses, and the technical community including the Chinese Society of Theoretical and Applied Mechanics, the Acoustical Society of China, and the IEEE UFFC-S will make the conference an international arena for technical exchange and promotion.

In addition to participate the extensive technical programs, I hope the participants can also find time to visit the famous Qinhuai River, Confucian Temple, Wuyi Alley, Lake Mochou, among others, to explore the city with a long history.

Enjoy your stay in Nanjing!



Symposium Chair

December, 2008

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摘要目录/Content

大会特邀报告

分会场报告

论文编号：001 Paper No.: 001

氮化硼管中的富勒烯汇聚——力热电磁的多层次耦合

杨卫

（浙江大学，杭州 310058）

论文编号：002 Paper No.: 002

An energy approach for Free Vibration of a Thick Piezoelectric Actuator

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(Department of Building and Construction, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong, P.R. China)

Abstract: Piezoelectric bending actuators have been widely used in position control, loudspeakers, vibration control and noise control. A piezoelectric actuator is a host element laminated with a piezoelectric material on the top and the piezoelectric material is normally poled in the thickness direction. Accurate modeling on the electromechanical interaction between host element and piezoelectric materials are required to design the system. It is important to predict the dynamic characteristics of a piezoelectric actuator for vibration and noise control. The aim of this paper is to extend the 2-dimensional model previously developed by the author to study the free flexural vibration of a thick elastic-piezoelectric two-layered actuator.

A new two-dimensional coupled electromechanical model for a 2-layered thick, laminated actuator with piezoelectric and isotropic lamina has been developed and its free vibration characteristics are investigated. The model adopted the first-order shear deformation theory for the central elastic core (i.e. considered as a Timoshenko beam) and linear piezoelectric theory for the piezoelectric lamina. The natural frequency of the beam is determined by using variational energy method and adopting the Ritz procedure with polynomial functions as the admissible functions to arrive at the governing eigenvalue equations. Different geometric effects are considered to investigate the vibration response of a thick laminated piezoelectric actuator.

Numerical examples have been carried out to investigate the geometric effects on the free vibration of

a thick piezoelectric laminate. In general, the longer the laminate, the lower the natural frequency and for lower modes of vibration, the frequency parameter increases with thickness of the piezoelectric layer. However, the trend reverses for higher modes of vibration.

Key words: Free vibration, laminated actuator, variational energy method, Ritz method

论文编号: 003 **Paper No.:** 003

A Review of the Recent Development of MEMS and Crystal Oscillators and Their Impacts on the Frequency Control Products Industry

C.S. LAM

(Epson Electronics America, Inc., San Jose, California, USA)

Abstract: Due to their high Q and temperature-stable properties, quartz crystal oscillators are important clock sources in consumer, commercial, industrial, and military products for many years. The demand for quartz crystals and crystal oscillators has been increasing steadily between 4 and 10% annually since the "dotcom" market collapse in 2000~2001. The total market for 2008 is expected to exceed $4.1B. The quartz crystal and crystal oscillator industry has made major progresses in miniaturization, performance enhancement, and cost reduction in the past ten years. The unique fabrication and encapsulation requirements though render quartz crystals and crystal oscillators difficult or close to impossible to be integrated onto the silicon-based IC platforms. The recent strong marketing push of the all silicon MEMS resonators and oscillators seemed to re-ignite the interest in displacing the quartz crystal technology and to open up again the prospect in clock source integration. Based on a 2006 review paper, the author expands on the subject by reviewing the development of the all silicon MEMS oscillators and crystal oscillators in the past few years and commenting on what challenges they face in the highly competitive frequency control products industry. Since information on the technical development of the all silicon MEMS oscillators and crystal oscillators is abundantly and readily available, this paper addresses more on the market and business aspects. This paper also touches on the recent development of piezoelectric-activated silicon MEMS resonators and oscillators and all silicon oscillators (with no moving parts).

Keywords: frequency control products, MEMS oscillator, crystal oscillator

论文编号：004 Paper No.: 004

Electromechanical Response and Polarization Switching of Electroded Piezoelectric Material Systems

Yasuhide SHINDO, Fumio NARITA

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Abstract: Piezoelectric material systems play a significant role as active electronic components in many areas of science and technology, such as smart structures and MEMS devices [1, 2]. In some device applications, high values of stress and electric field arise in the neighborhood of a crack tip or an electrode tip in piezoelectric ceramics and composites, and the stress and electric field concentrations can result in electromechanical degradation or catastrophic failure of the devices. One of the limitations for practical use of piezoelectric ceramics and composites is also their nonlinear behavior, which occurs due to polarization switching [3] and/or domain wall motion [4] at high electromechanical field levels. Hence, it is important to understand the nonlinear electromechanical fields near the crack tip or the electrode tip in piezoelectric material systems and to improve the device's design and performance. In recent years, work on fracture and fatigue crack behavior of piezoelectric ceramics has been reported in a combined numerical and experimental approach [5, 6]. The behavior of electromechanical fields in the vicinity of electrodes in piezoelectric material systems has also been investigated [7].

The main aim of this work is to report the electromechanical response and polarization switching of piezoelectric bimorph bender and laminated tension actuators. First, the nonlinear response of piezoelectric bimorphs is theoretically and experimentally examined, and the effects of electric field, mechanical load and polarization switching on the bending properties are discussed. The results on the nonlinear bending response are also presented for the functionally graded piezoelectric bimorphs under electric fields. Next, the effect of applied voltage on the electromechanical field concentrations ahead of circular electrodes in piezoelectric disks and disk composites is examined. The strain near the electrodes is measured, and the field concentrations are calculated. A comparison of strain concentration is made between experiment and simulation, and the nonlinear response induced by polarization switching is discussed. Finally, the nonlinear electromechanical fields near surface and internal electrodes in fully and partially poled piezoelectric laminates are presented.