The 8th Meeting of the MidSouth Chapter of the Acoustical Society of America

The University of Mississippi Oxford, MS 38677

April 15-16, 2011

Meeting Proceedings

Meeting Schedule:

Friday, April 15

5:00-5:45PM	:	Meeting Registration & Welcome
5:45-6:30PM	:	Grilled Burgers at Swayze Field
6:30-8:30PM	:	Ole Miss vs Kentucky Baseball Game

Saturday, April 16

7:30-8:30AM	:	Registration, Coffee & Donuts
8:00-10:00AM	:	Morning Session
10:00-11:00AM	:	Poster Session & Break
11:00-12:45PM	:	Closing Session
12:45-1:45PM	:	Exec. Comm. Meeting & NCPA Tour

Meeting Location: The meeting will be held in the auditorium of the National Center for Physical Acoustics located on the University of Mississippi campus. Posters will be displayed in the atrium and hallway near the main entrance. Check the Chapter website for a campus map as well as other information about Oxford, MS.

Special thanks to Jim Chambers, Josh Gladden and George Atkins at the National Center for Physical Acoustics for organizing and hosting the meeting.

Announcements: The next meeting of the MidSouth Chapter of the Acoustical Society of America will be in the fall of 2011.

Check the chapter website:

`http://www.acosoc.org/RegChapters/MidSouth/`

for more details about the upcoming meeting in the months ahead.

Oral Abstracts

SATURDAY, 16 April 2011

8:00-9:00 AM

Vibration Isolation for Advanced LIGO. Brian O'Reilly (Caltech-LIGO, P.O. Box 940, Livingston, LA 70756, brian@ligo-la.caltech.edu)

The Advanced LIGO project will improve the sensitivity of the instruments by a factor of ten and move the lower limit of the sensitive frequency range from 40 Hz down to 10 Hz. To achieve this significant improvements in the areas of seismic isolation, suspension of the test mass optics and mitigation of other sources of vibrational noise will be required. An overview of the techniques and hardware which is currently being assembled will be presented.

9:00-9:15 AM

Vibrational and Acoustic Response of Transient Bridge Loading. R Daniel Costley*, Henry Diaz-Alvarez, Mihan H. McKenna (U.S. Army Engineer Research and Development Center, U.S. Army Corps of Engineers, 3909 Halls Ferry Road, Vicksburg MS 39180, dan.costley@usace.army.mil)

A benchmark model for transient excitation of a simple structure was previously investigated: the FEA and analytical solutions were compared for the transient excitation of a 2-D Euler Beam. The specific loading being considered was a point load traveling the length of the beam. The response of the beam depends on the speed of travel and the lower order modes of vibration. Comparison of the FEA and analytical results showed excellent agreement. This methodology was developed to determine vibration responses of bridges under vehicle loading. Modeling and experimental results have been obtained for a single axle with two wheels and variable combinations of locomotives and empty flatcars transiting a railroad bridge at Ft. Leonard Wood, MO. This method of excitation could potentially be used to remotely provide information on the capacity and number of the vehicles traversing the bridge. Another potential application is structural health monitoring. The analysis includes examining the vibrational response of the bridge and determining which vibrational modes radiate infrasound.

9:15-9:30 AM

High temperature Resonant Ultrasound Spectroscopic (RUS) Study of elastic Properties of Novel Ceramics used in Solid Oxide Fuel Cells (SOFC). Sumudu Tennakoon* and Joseph Gladden (Department of Physics and Astronomy, National Center for Physical Acoustics, University of Mississippi, University, MS 38677, sptennak@olemiss.edu)

Solid Oxide Fuel Cells (SOFC) are composed of anodes, cathodes and electrolyte all are ceramic based materials which is in contrast to other types of fuel cells currently in use. These ceramic materials formed by hot pressing multiple thin ceramic sheets. SOFC fuel cells can operate at temperatures as 500 C -1000 C. Therefore, knowing elastic properties of these ceramic materials at high temperature is important in designing fuel cell assemblies for practical usage. In this study, two types of anodes ceramic materials and one type of solid oxide electrolyte ceramic material used in a prototype SOFC were examined. Resonant Ultrasound Spectroscopy (RUS) technique was used to determine elastic properties. Measurements were carried out using both direct contact transducer and buffer rod systems. A thin platinum layer was sputtered on the sample surfaces in contact with transducer to avoid a temperature enhanced chemical reaction with gold coated transducer and the nickel based ceramic samples at high temperatures. As an initial step, elastic properties were studied at room temperature. High temperature study was performed by acquiring RUS data from room temperature to 550 C for every 50 C and on the way up and for every 100 C on the way down. Resonance data were compared by fitting in to both isotropic and hexagonal symmetry models. Variation of quality factor (Q) with temperature was examined as a measure of acoustic attenuation.

9:30-9:45 AM

Equilibrium Dynamics of Palladium Hydride near the Tri-Critical Point. Rasheed Adebisi* and Joseph Gladden (University of Mississippi, National Center for Physical Acoustics, Room 1077, RUS LAB, NCPA, University of Mississippi, University, MS 38677, raadebis@olemiss.edu)

The slow hydrogen sorption kinetics in light-metal systems is a major hurdle that must be overcome in the quest for on-board reversible hydrogen storage applications. Upon entering into the surface of metal, hydrogen molecules in gas phase dissociates into pair of hydrogen atoms and occupy either the tetrahedral interstitial sites in metals with BCC lattices or octahedral interstitial site in metals with FCC lattices such as palladium. Palladium hydride (PdHx) exists in two phases. At room temperature, the low concentration (PdHx=0.02) called αphase, has slightly larger lattice parameter compared to that of pure palladium. Above this concentration and up to PdHx=0.6 the high concentration βphase appears resulting in $(\alpha + \beta)$phase, a mixed phase region and the lattice parameter becomes substantially greater than that of pure palladium. When x ¿ 0.6, αphase disappears and the system becomes purely βphase. The three phases coexist at the tricritical point (temperature, pressure and concentration). Resonant Ultrasound Spectroscopy (RUS) has been used to investigate the elastic constants of palladium hydride crystal and the equilibrium dynamics of the system around the tricritical temperature and pressure. The correlation between the elastic constant data, the equilibrium dynamics data and the existing phase diagram will aid in the understanding of the equilibrium behavior of the hydride around the tri-critical point.

9:45-10:00 AM

Mechanical properties of Poly(vinylidene fluoride) nanocomposite thin films containing multi-walled carbon nanotubes. Qin Zhang*, Rasheed Adebisi & Joseph Gladden (National Center for Physical Acoustics, The University of Mississippi, University, MS 38677, qzhang@olemiss.edu)

The preparation and characterization of poly(vinylidene fluoride) (PVDF)/multi-walled carbon nanotube (MWCNT) nanocomposite thin films with a composition range from 1.0 to 5.0 wt % MWCNT by weight is reported. The PVDF/MWCNTs mixture was formed using solution blending and the ultrasonic dispersion method and then spin-coated on a rotating glass substrate to produce films nearly 20 microns thick. The mechanical properties of the resulting films were examined and compared to the pure PVDF films through the mechanical tensile tests. Results indicate that the addition of MWCNTs (up to 3.0 wt %) to PVDF tends to increase its elastic modulus while decrease its fracture toughness. The elastic modulus shows softening at a 5.0 wt % MWCNT loading.

10:00-11:00 AM

Poster introductions (3 min each) followed by poster session & break.

11:00AM-11:15 AM

Mechanisms of Ultrasonic Attenuation in Porous Bone. Stephanie Milazzo* and Brent Hoffmeister (Rhodes College, 2000 North Pkwy, Memphis, TN 38112, milsm1@rhodes.edu)

Ultrasound is a well established method for measuring density changes in porous bone caused by osteoporosis. Some investigators have proposed that ultrasonic backscatter techniques may be useful for this purpose. Backscattered power has been found to decrease with bone density. We have hypothesized that increases in attenuation due to increased specimen density cause a decrease in the measured backscattered power. There are two mechanisms of attenuation in porous bone: 1) absorption (conversion of acoustic energy to heat), and 2) scattering of acoustic energy away from the forward direction. To determine the dominant mechanism for attenuation, we measured 8 specimens of human and bovine bone ranging in density from 0.142-0.259 g/cc. Measurements were first performed with the specimens in water (with water filling the porous regions) and then in ethanol. By altering the saturating fluid, we altered the scattering properties of the bone, but not the absorption properties. We observed differences in the backscattered signals between water and ethanol measurement trials, but not between attenuation signals. This suggests that the dominant mechanism of attenuation is absorption and not scattering.

11:15-11:30 AM

Modified version of cadence frequency algorithm for broadband periodic signals. Alexander Ekimov (The National Center for Physical Acoustics, The University of Mississippi, University, MS 38677, aekimov@olemiss.edu)

Rhythm algorithm developed for periodic broadband signals of human/animal motion due to walking shows that their cadence frequencies are comparatively stable in time and this phenomenon allows their recognition in measured signals. The current version of the algorithm involves an explanation of how to choose time windows for arbitrary periodic physical process on the base of process characteristic time scales (duration and repetition times). The window time scales extend existing in the literature algorithm (Houston et al. "Spectrum analysis techniques for personnel detection using seismic sensors," SPIE, 5090, 2003) for another classes of periodic broadband signals. As an example of developed algorithm application, experimental results for short distance (50 m) signatures of walking human/animals, recorded simultaneously with a node of four orthogonal sensors at two locations (forest and building hallway) are presented and discussed. The sensor types were active Doppler ultrasonic sonar and Doppler radar, and passive seismic/ultrasonic. Movements of human and animal bodies, resulting from walking, are periodic and these movements produce pulse sequences with characteristic repetition and duration times. Extraction of these pulse sequences from nonperiodic or even periodic background noise floor is a goal of the proposed modification of the rhythm algorithm. Example of extension of this modified version of the cadence algorithm for other class of periodic signals (underwater signals) is presented also.

11:30-11:45 AM

LDV-based MASW technique for near surface soil exploration. Zhiqu Lu (The National Center for Physical Acoustics, The University of Mississippi, University, MS 38677, zhiqulu@olemiss.edu)

In todays world, many applications require near surface soil information, including areas such as agriculture, civil engineering, military, and the environment. To explore near surface soil in a non-invasive manner, a laser Doppler vibrometer (LDV) based multi-channel analysis of surface wave (MASW) method has recently been developed at NCPA. In the method, an electro-mechanical shaker was used as a seismic source operating in a frequency sweeping mode to excite Rayleigh waves propagating through the soil surface. The surface vibrations along a straight line were detected by a moving LDV. Two spectral analysis techniques and an inversion algorithm were used to determine the 1D soil profile in terms of shear wave velocity. 2D image was obtained by repeating the 1D scan procedure. Unlike the conventional MASWs that explore soil profile from a few meters to a few tens of meters below the ground, the present MASW investigates underground depth from a few centimeters to a few meters due to its high frequency excitation and high spatial resolution of moving LDV.

11:45 AM - 12:00 PM

The effect of sample properties on photoacoustic signal generation. Logan Marcus (The National Center for Physical Acoustics, The University of Mississippi, University, MS 38677, LSMarcus@olemiss.edu)

The photoacoustic effect is a powerful tool for the interrogation of the physical properties of a known substance. A model of the photoacoustic effect was developed to study the phenomenon. The model investigates the signal that would be measured by a Laser Doppler Vibrometer (LDV). Signal is generated by two different mechanisms the surface expansion of the sample from periodic heating and the changes in index of

refraction of air by heat transfer from the sample to the gas layer. Two samples with different physical properties were studied using the model to analyze the different signal generation methods. The calculations indicated a difference in signal generation based on the properties of the sample. An experiment was devised to verify the model by separating the two sources of signal generation. Separation was achieved by eliminating the signal generated by the index of refraction changes. This was done by placing the sample into a vacuum chamber and measuring the photoacoustic signal as the chamber was slowly evacuated. Experimental results indicate that signal generation is indeed dependent upon the properties of the sample under examination, and confirms the predictions of the simple model.

12:00 PM - 12:15 PM

Measurements of Atmospheric Boundary Layer Related Surface Pressure Fluctuations. Nathan Murray (The National Center for Physical Acoustics, The University of Mississippi, University, MS 38677, nmurray@olemiss.edu)

Turbulence in the atmospheric boundary layer (ABL) results in fluctuations in barometric pressure measurements obtained on the Earth's surface. These relatively low-frequency fluctuations have spectral characteristics similar to infra-sound; however, the disturbances do not propagate with the speed of sound. Rather, the propagation speed is related to the convection velocity of turbulent eddies of various sizes in the ABL. An experiment was conducted in the Mississippi Delta using a 49 element array to observe the propagation of these disturbances as a function of frequency and/or wavelength. Details of the experimental setup and initial results are presented.

12:15 PM - 12:30 PM

Porosity effects in large wind screening structures. JohnPaul Abbott (The National Center for Physical Acoustics, The University of Mississippi, University, MS 38677, jrabbott@olemiss.edu)

Infrasonic noise generated by wind turbulence is one of the primary sources of interference for detecting long range acoustics signals. Current development of devices and techniques to reduce this noise has met with limited and varied success. Pipe and porous hose arrays, for example, are effective but also limited by a large spatial footprint and tendency to affect acoustic waveforms and signals. Recently completed research indicates that the dominant form of wind noise for infrasonic microphones placed on open ground is the interaction pressure of the gradient of the average horizontal wind velocity profile and the vertical component of the wind turbulence field. It has been hypothesized that significant noise reduction can be achieved with a smaller spatial footprint and little effect to the acoustic wave forms by reducing the gradient of the horizontal wind velocity above the microphone and modifying the turbulent with a relatively large porous screen. To investigate this hypothesis a 3 meter high decagonal wind barrier with variable porosity has been constructed. The noise reduction results will be related to the measured wind profiles and turbulence spectra inside the enclosure.

12:30 PM - 12:45 PM

Development of qualitative lab elements for teaching acoustics to architects in the context of environmental control systems at Louisiana State University. Dave S. Woolworth (Oxford Acoustics, Inc., 356 CR 102, Oxford, MS 38655, dave@oxfordacoustics.com)

The Environmental Control Systems 3008 class at LSU provides architects with a basic understanding and integration of light, climate and acoustic control systems in the building design process. Since the material is generally quantitative, a qualitative lab based approach for acoustics was integrated based on previous work by Egan, Siebein, Newman, Cavanaugh, and others. This paper presents the general approach taken to the acoustics portion of the class, with modifications to the qualitative exercises created by the aforementioned authors. Examples of the student work will be presented as well.

Poster Abstracts

Testing system components for a low-frequency, impulsive Helmholtz Resonator. John Lahmann*, Stephen R. Addison, William V. Slaton and Carl Frederickson (Department of Physics, The University of Central Arkansas, Conway AR 72035, lahmannjohn@yahoo.com)

Infrasound can be used to probe a variety of physical systems; this includes the determination of ground characteristics, the detection of explosions, and the investigation of tornadoes and hurricanes. Infrasound detectors have been deployed around the world as part of the monitoring required by UN Comprehensive Nuclear Test Ban Treaty. A reproducible calibrations system would enable this network of sensors to be used for basic science. We describe work that is being performed to design an appropriate calibration system. A large, impulsive Helmholtz resonator appears to be an ideal candidate to serve as the sound source in a mobile, reproducible calibration system for infrasonic detectors. Efforts to date have focused on the development of a reproducible triggering mechanism. Measurements have been performed with the system that will constitute the throat of the planned larger oscillators. The resonator throat consists of 2-foot long stainless steel pipe, with an inside diameter of 4 inches, that is closed at both ends. Using a flange, we have securely sealed one end of the pipe. At the other end of the pipe, we use different thicknesses of sheet aluminum to form a diaphragm; the aluminum sheets are held on by an open flange. To create the sound pulse, we produce a vacuum in the pipe and trigger the resonator by puncturing the diaphragm, causing it to rupture. Work to date has concentrated on the development of the triggering mechanism. The various methods of triggering the resonator will be discussed. Some preliminary data will be presented.

Determination of Elastic Moduli in Brass, Aluminum, Wood and Plastic Rods Using Resonance. Roy Truett French III* and William V. Slaton (Department of Physics, The University of Central Arkansas, Conway AR 72035, treyman09@gmail.com)

This experiment investigated how to excite the Flexural and Torsional modes in Brass, Aluminum, Wood, and Plastic rods. The setup consists of a two channel dynamic signal analyzer, a power amp, an operational amplifier and high pass filter circuit. Two coils of copper wire act as transducers on each end of the rod. The rod is suspended with the transducer coils in strong magnetic fields provided by neodymium magnets. The signal analyzer sends a swept sine wave into the power amplifier which drives one transducer coil. The rod's response is measured with the op-amp circuit connected to the second transducer coil which is connected to the signal analyzer. The resonance peaks were found using the two channel dynamic signal generator. With these peaks, the Flexural and Torsional modes can be determined, thereby allowing one to calculate the Elastic Moduli.

Aeroacoustic Source Strength Measurement of Helmholtz Resonators. Asami Nishikawa* and William V. Slaton (Department of Physics, The University of Central Arkansas, Conway AR 72035, asami.nishikawa@gmail.com)

The aero-acoustic excitation of a Helmholtz resonator with different neck geometries and the work done to sustain the excitation of resonance will be examined with an improved measurement technique. A Helmholtz resonator consists of a volume connected to a duct and has a well defined resonance frequency which depends on the length of the duct, the volume of the resonator and the cross sectional area of the duct. In the system used during this experiment, two Helmholtz resonators have been positioned at opposite sides of a junction in a wind tunnel. The air flowing over the junction openings to the Helmholtz resonators can excite the acoustic resonance of the system. This is similar to blowing over an empty bottle's opening and creating a tone. The effect of the resonator's geometry has been seen in the measured acoustic amplitude and frequency in the resonator. And the work done by the aeroacoustic source of sound can also be determined through the measurement of the air speed in front of and behind the junction in the wind tunnel.

Speed of a Pulse on a Taut Wire. Tristan Odekirk* and William V. Slaton (Department of Physics, The University of Central Arkansas, Conway AR 72035, tjodekirk@gmail.com)

In high school and undergraduate general physics classes the speed of a wave on a string is taught with an accompanying lab experiment using standing waves. However, it is possible to economically demonstrate the speed of a single pulse on a guitar string with high precision using basic lab equipment and open-source oscilloscope software which uses the computer's sound card. This software is available at:
`http://www.zeitnitz.de/Christian/scope_en`