8:45

5aEA2. Approaches to simulate electromechanical coupling in voided piezoelectric materials. Juan Arvelo, Jr. (Johns Hopkins Univ., Appl. Phys. Lab., 11100 Johns Hopkins Rd., Laurel, MD 20723-6099) and Ilene Busch-Vishniac (Johns Hopkins Univ., Baltimore, MD 21218-2681)

Recent work has demonstrated piezoelectric behavior in voided polymers. It is thought that the piezoelectricity results from the creation of space charges bordering the voids when the material is exposed to an electric field in excess of the breakdown strength. The resulting voided piezoelectric material is more flexible than conventional piezoelectric ceramics, and may be far less expensive to manufacture. Accurate models of piezoelectricity in voided materials are needed to explore the limits of performance and their use under a wide range of conditions. We are using finite element analysis to develop a model of the mechanical, electrical, and piezoelectric behavior in voided materials. Results for some of the materials of current interest, such as low-density polypropylene (LDPP) and porous polytetrafluoroethylene (PTFE) will be presented. [Work performed under a JHU/APL sabbatical to the JHU/WSE.]

9:00

5aEA3. Simulation of linear aeracoustic propagation in lined ducts with discontinuous Galerkin method. Christophe Peyret and Philippe Delorme (ONERA BP, 72 Chatillon, France)

The simulation of the acoustic propagation inside a lined duct with nonuniform flow still presents problems when geometry is complex. To handle computations on a complex geometry, without consequential effort, unstructured meshes are required. Assuming irrotational flow and acoustic perturbation, a well-posed finite element method based on the potential equation is established. But, the effect of the thin boundary layer is then neglected, which is not relevant to the acoustical processes occurring near the lining. Recent works have focused on the tremendous interest of the Galerkin discontinuous method (GDM) to solve Euler's linearized equations. The GDM can handle computations on unstructured meshes and introduces low numerical dissipation. Very recent mathematical works have established, for the GDM, a well-posed boundary condition to simulate the lining effect. Results computed with the GDM are presented for a uniform cross section lined duct with a shear flow and are found to be in good agreement with the modal analysis results, thereby validating the boundary condition. To illustrate the flexibility of the method other applications dealing with instabilities, air-wing diffraction, and atmospheric propagation are also presented.

9:15

5aEA4. Engineering acoustic lenses with help from evolution. Andreas Håkansson, José Sánchez-Dehesa, and Lorenzo Sánchis (Nanophotonic Technol. Ctr. and Dept. of Electron. Eng., Polytechnic Univ. of Valencia, Spain)

Optimization engineering through evolutionary algorithms have proven to be very efficient, especially in hard problems containing a large set of optimization parameters. Like evolution this family of algorithms is able to tackle enormous complex problems with fairly simple means. Here, a simple genetic algorithm [J. H. Holland, *Adaptation in Natural and Artificial Systems* (Univ. of Michigan, Ann Arbor, 1975)] is used in conjunction with the multiple scattering theory [L. Sánchis *et al.*, Phys. Rev. B **67**, 035422 (2003)] to fabricate a new generation of acoustic devices based on a discrete number of cylindrical scatterers. In particular, acoustic lenses [F. Cervera *et al.*, Phys. Rev. Lett. **88**, 023902 (2002)] with flat surfaces have been designed to focus the sound in a fixed focal point for one or multiple frequencies. Each scatterer is carefully placed using the optimization method within the preset boundary conditions, to maximize the pressure contribution in the chosen focal spot. With this method acoustic lenses with very low f-numbers of the order 0.3 and with amplifications over 12 dB have been estimated using a reduced number of scatterers ($\sim$60). Preliminary results obtained from the experimental realization of the designed devices confirm our predictions.

9:30

5aEA5. An application of boundary element method calculations to hearing aid systems: The influence of the human head. Karsten B. Rasmussen (Oticon A/S, Strandvejen 58, DK-2900 Hellerup, Denmark) and Peter Juhl (Univ. of Southern Denmark, Campusvej 55, DK-5230 Odense M, Denmark)

Boundary element method (BEM) calculations are used for the purpose of predicting the acoustic influence of the human head in two cases. In the first case the sound source is the mouth and in the second case the sound is plane waves arriving from different directions in the horizontal plane. In both cases the sound field is studied in relation to two positions above the right ear being representative of hearing aid microphone positions. Both cases are relevant for hearing aid development. The calculations are based upon a direct BEM implementation in Matlab. The meshing is based on the original geometrical data files describing the B&K Head and Torso Simulator 4128 combined with a 3D scan of the pinna.

9:45

5aEA6. Dissipative silencers with an extended inlet/outlet and baffles. Ahmet Selamet, Iljae Lee, Mubing Xu (The Ohio State Univ., 930 Kinnear Rd., Columbus, OH 43210, selamet.1@osu.edu), and Norman Huff (Owens Corning Automotive, Novi, MI 48377)

The acoustic characteristics of a single-pass perforated dissipative silencer were investigated experimentally and numerically by Selamet *et al.* [J. Acoust. Soc. Am. **109**, 2364 (2001)]. The current study extends this work by considering variations in the internal structure of the dissipative silencer. In addition to the boundary element method (BEM) introduced earlier, a multi-dimensional analytical approach is now developed to investigate the wave modes and transmission loss. Both methods are then employed to study the effect of an extended inlet and outlet on the acoustic behavior of the silencer. BEM is further used to explore the effect of baffles and air space inside the dissipative chamber. The location and number of baffles inside the dissipative chamber are shown to have a significant influence on the transmission loss.

10:00

5aEA7. Acoustic waves in discrete media, similarities at meso and nano scales. Hasson Tavossi (Dept. of Physical and Environ. Sci., Mesa State College, School of Math. and Physical Sci., 1100 North Ave., Grand Junction, CO 81501)

In this paper the similarities between the acoustic behavior of a discrete medium of random arrangement of solid spheres, at mesoscopic scales, and thermal vibrations of lattice ions in crystalline solid, at nano scales, are investigated. Results for the ultrasonic waves in random media show that such effects as cutoff frequency, wave dispersion, energy distribution in vibration modes, wave attenuation by scattering and absorption, observed in discrete media, have close resemblance to the similar phenomena observed at atomic scales, such as phonons or lattice thermal vibration of atoms in the crystalline solids. For example, the cutoff frequency in lattice vibration is related to the interatomic spacing, similarly, the cutoff frequency at mesoscopic scales depends on grain separation or grain size. These similarities are also observed in wave scattering and attenuation and their dependence on wave number, kR ($k=2\pi/\lambda$ and R is particle size). In this paper experimental measurements with data analysis on cutoff frequency, wave attenuation, and wave dispersion related to the above mentioned similarities will be presented, and the extension of these findings to the behavior of acoustic waves in other discrete media will be discussed.