difference to traditional ferroelectric materials. Here we summarize our present understanding of ferroelectrets.

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Session: 4D

PHYSICAL ACOUSTICS II

Chair: S. Schneider
Marquette University

4D-1  8:30 a.m.

EXPERIMENTAL STUDY OF BAND GAPS AND DEFECT MODES IN A TWO-DIMENSIONAL ULTRASONIC CRYSTAL

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Acoustic band-gap materials, also called phononic crystal, are composite elastic media, constituted of two- or three-dimensional periodic repetitions of different solids or fluids. Similarly to photonic band gap materials where the propagation of light is prohibited in some frequency range, these elastic periodic composites can exhibit large acoustic band gaps where the propagation of the phonons is forbidden. A phononic crystal can, therefore, behave like a perfect mirror for the propagation of vibrations in some frequency range and have potential applications in transducer technologies, filtering and guidance of acoustic waves.

When a defect or a cavity is introduced in the otherwise perfect crystal, localized modes can be created that are associated with the defect in the band gap of the phononic crystal. We present an experimental and numerical investigation of the properties of band gaps and a variety of defect modes in a two-dimensional array of steel cylinders immersed in water. The 2.5-millimeter-diameter steel cylinders are clamped at one end into a rigid steel plate perforated with a 3-mm period and a ten-micron precision. Two wide-bandwith acoustic transducers operating around 500 kHz and launching short pulses are used to measure the transmission and reflection of acoustic waves propagating in the structure. We observe that acoustic waves cannot propagate within certain frequency ranges. We also demonstrate that by removing a single rod from an otherwise perfect lattice we create a highly localized cavity mode. This mode splits into two resonance modes when two consecutive single rods are removed. The results are discussed in relation with numerical simulations performed with a finite difference time domain (FDTD) method. It is found that theoretical predictions fairly account for the observed spectra.
PHENOMENOLOGICAL STUDY AND SELECTIVITY RAISING OF PHONONIC CRYSTALS

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Phononic crystals - periodic elastic structures - exhibit frequency regions where the waves cannot propagate. These regions are named forbidden acoustic band gaps. Acoustic band gaps affect radiation-matter interactions in phononic crystals and can improve the performance of acoustic devices. For the phononic crystal devices designing there arises a necessity to developing phenomenological models with clear interpretation of the relationships between phononic crystal structures and characteristics. In the paper we present such model based on equivalent reflection sources. This model has been demonstrated to yield vary accurate results when compared to exact calculation of dispersion diagrams. We have shown that phononic crystal dispersion is analogous to waveguide dispersion. This analogous is explained by the same physical phenomena - multibeam interference of waves. Multibeam interference of the reflected waves in phononic crystal has destructive character in permission (transmission) acoustic band gaps. The model suggested gives clear physical explanation and principal technical solution for raising of the reflected waves compensation in transmission acoustic band gaps. This yields much higher phononic crystal selectivity. In order to illustrate model accuracy and selectivity raising a comparison of dispersion diagrams and transduction/reflection characteristics of conventional and new designs will be shown.

NUCLEAR ACOUSTIC RESONANCE FOR THE DETECTION OF FISSILE MATERIAL

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The detection of fissile materials is of interest to the National Homeland Security effort. Important requirements are that (1) the technique present no radiation hazard to the operator, (2) that the technique detect through intentional shielding, and (3) the technique is non-intrusive (nondestructive). In this paper we discuss the approach based on nuclear acoustic resonance (NAR). Here high intensity radio frequency acoustic waves cause shifts in the materials’ electronic and nuclear spin energy levels when the material is acoustically driven in the presence of a constant magnetic field. Nuclear energy level shifts induce changes in the material’s unique nuclear magnetic properties which can be measured using very sensitive instruments. The physics and detection principles will be
described in detail and selected examples of NAR will be presented along with analytical and experimental results.

4D-4 9:30 a.m.

NON-LINEAR ACOUSTICMAGNETIC WAVE INSTABILITY UNDER RESONANCE MAGNETOACOUSTIC INTERACTION
A. S. BUGAEV* and V. B. GORSKY, Moscow Institute of Physics and Technology.
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The nonlinear effects of acoustic modes efficiently coupled with magnetostatic waves (MSW) have been investigated experimentally and explained. Efficient wave coupling was realized under the phase synchronism of spin-wave resonances and transversal acoustic modes. Planar structures with yttrium-iron garnet films of 3-10 mcm thick were used in experiments at frequencies in 2.6-8 GHz range. Experimental environment enabled to excite both transversal acoustic modes and exchange spin waves (spin wave resonances) and dipole magnetostatic waves in the same frequency range. Dipole MSW and exchange SWR modes had the same wavevector component in the plane of the film, SWR modes and acoustic modes have the same wave vector. It was shown that any acoustomagnetic excitation in the frequency range to be described as a combination of three components: dipole, exchange and acoustic. The ratio of the components in any mode depends upon position of the mode in the spectrum. The nonlinear threshold of such excitation have been compared experimentally with instability threshold of dipole MSW and exchange SWR. The 8-12 dB threshold variation have been observed for acoustomagnetic modes compare to original magnetostatic modes. The non-linear threshold was detected using magnetic susceptibility measuring, frequency spectrum of the signal reflected from the microwave resonator, and using impulse signal cutoff. The threshold variation (both decrease and increase) have been observed even without any visible spectrum modification.

4D-5 9:45 a.m.

EFFICIENT HYPERSONIC BEAM EXCITATION METHOD
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The efficient magnetostrictive bulk hypersonic waves excitation with varied beam diameter in microwave frequency range has been investigated theoretically and experimentally. Acoustic waves (AW) have been excited by magnetostatic waves (MSW) in ferrite films. Efficient excitation was achieved under the triple resonance acoustic wave - dipole MSW - exchange MSW interaction. Insertion
losses of 7dB have been obtained in 2-8.5 GHz frequency range. The width of the beam can be fluently varied in 100mcm – 1 mm range. The dynamics of the acoustic wave excitation have been investigated which reveals the features of impulse excitation in planar structure. Optimal condition for efficient AW excitation, when one half of common losses of the mode is transformed to acoustic wave energy, have been achieved in any YIG film (6-12 mcm thick) at any surface conditions.

Session: 5D

SAW RF FILTERS
Chair: C. Ruppel
EPCOS AG

5D-1 8:30 a.m.

THE APPROACH TO REALIZE THE CHARACTERISTICS OF SAW RESONATOR WITH THE TEMPERATURE COMPENSATION AND STEEPNESS FOR PCS DUPLEXER

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In order to transmit and receive signals simultaneously, the antenna duplexer is necessary device for the cellular phone. Because the antenna duplexers require high quality characteristics and high power durability, dielectric antenna duplexers have been used conventionally. However, recently, the quality and the power durability of SAW filters have been improved dramatically and SAW antenna duplexers have been developed and put to practical use in several cellular phone systems. However, in the PCS in US, which is one of the system using CDMA, SAW antenna duplexer has not been in practical use, yet. The frequency allocation of US-PCS consists of both 1850-1910 MHz Tx band and 1930-1990 MHz Rx band. Therefore the cross-band width is 20 MHz, which is only about 1 % fractional band width. Moreover, when we design the filter for PCS duplexer, the actual cross-band is narrower because of the temperature coefficient of frequency (TCF) of a substrate. These make realization of PCS SAW duplexer using conventional LT substrate and design technology difficult. Against these backgrounds, we have proposed the band-switching antenna duplexer that consists of two duplexers, as the one of the method using conventional substrate and design technology. In this time we examined the feasibility of full-band SAW PCS duplexer. As I mentioned above, it is necessary to improve the temperature coefficient and steepness of the resonators which the filters consist of. To improve temperature coefficient of LT, we have adopted the method using SiO2 film. When the resonator is covered with SiO2, TCF is improved and steepness becomes sharp due to capacitance ratio increasing. However, in case of the resonator with SiO2 of which TCF is approximately 0 ppm/C, it is difficult to