Patch-transducers based on ferroelectret films for Lamb and surface acoustic waves generation and reception.

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Ferroelectret (FE) films have been used for pressure sensors, air-coupled ultrasonic transducers (0.2-0.6 MHz) and patch transducers for heart beat and respiration monitoring. The present work is motivated by an initial study of Lamb wave propagation in FE films and the electromechanical conversion associated to these propagation modes. Using the coincidence principle and air-coupled ultrasound (0.4-0.8 MHz) it was possible to detect the S_0 Lamb mode in various FE films and to measure a clear electromechanical activity. These study also revealed that FE are orthotropic and ultrasound longitudinal velocity is 3000 and 2100 m/s for propagation along the two in-plane axis and 120 m/s along the axis normal to the film plane.

These results suggest the possibility to produce patch transducers based on FE films to excite and receive Lamb and surface acoustic waves in different solids. Structure of the proposed patch transducer is shown in fig. 1. The protective layer is a 100 nm thick spin-coated PPMA layer and the adhesive layer is a pressure contact adhesive film (50 µm thick); $w = \lambda/3$, where λ is the wavelength of the Lamb or surface wave and l = 20 mm. Two basic configurations has been tested (Fig. 2): i) single patch-transducer and ii) comb-array patch-transducer (up to four elements), with separation between strips = λ. This second configuration permits to boost signal amplitude and to improve signal to noise ratio. These patch transducers have been successfully used along with an Olympus 5077 pulser-receiver to both excite and receive the Lamb A_0 mode in different plates: 1.5 mm aluminum, 1,5 mm PVC and 4 mm fiber carbon reinforced composite, and for surface waves in thick PMMA plates. Fig. 3 shows the received A_0 Lamb mode in the Al plate using the configuration shown in Fig. 4. In all cases, the peak sensitivity is obtained at the λ/4 resonance of the FE film thickness mode: 320 kHz. Design alternatives and possible applications in health monitoring and NDT are discussed.

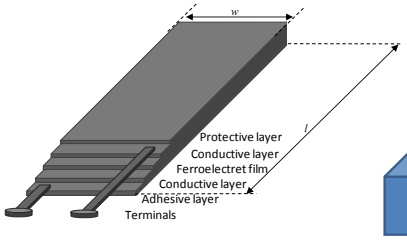

Fig. 1. Patch structure

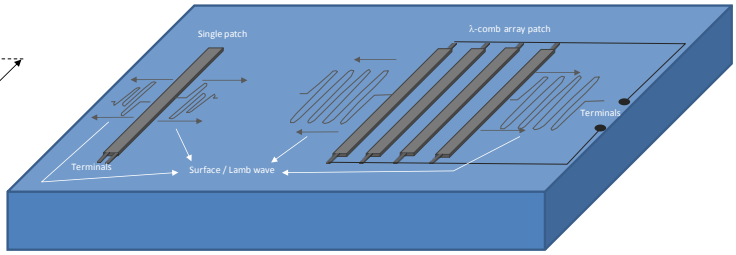

Fig. 2. Single patch (left) and comb array (right)

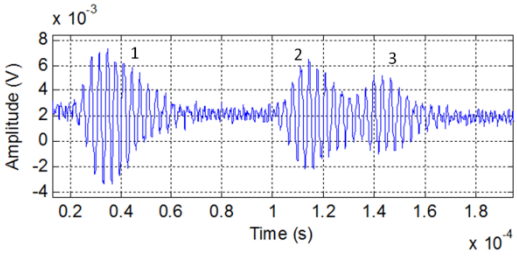

Fig. 3 Received Lamb wave in a 1.5 mm thick aluminum plate

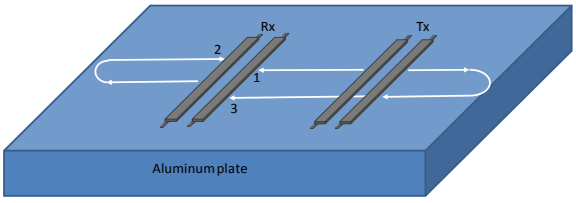

Fig. 4. Experimental set-up for measurement in Fig.3