# Piezoelectrets: Novel Transducer Materials for Mechanic and Acoustic Applications

Biao Zhu[1], Xiaoqing Zhang[2], Peng Fang[3,*], Jie Zheng[1], Tao Liu[1], Zeyang Xia[3], and Guanglin Li[3]
[1]Shenzhen Horn Audio Co. Ltd.
No.6, 4th Guihua Road, Pingshan Shenzhen, China, 518118
[2]School of Physics Science and Engineering, Tongji University
1239 Siping Road, Shanghai, China, 200092
[3]Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
1068 Xueyuan Avenue, Shenzhen, China, 518055
*Corresponding Author Peng Fang: peng.fang@siat.ac.cn

Piezoelectrets, also known as ferroelectrets, are polymer-based space-charge electrets with piezoelectric effects [1]. Their piezoelectricity originates from a combination of the internally stored quasi-permanent charges, which is the intrinsical nature of electrets, and the heterogeneous cellular structures. Piezoelectrets exhibit several advantages, including the large piezoelectric sensitivity, low acoustic impedance, low elastic modulus, flexibility, low cost, etc., which would make them very desirable for transducer applications [2].

In this work, piezoelectrets were prepared from polypropylene (PP) films. A gas-press-expansion [3] treatment was applied to adjust the micro cellular-structure of the original films, and corona charging was used to render the films piezoelectric. Properties were assessed by means of the dielectric resonance spectra, the mechanical measurements both in quasi-static and dynamic ways, and the acoustic tests. Furthermore, microphones were fabricated by stacking multiple piezoelectret layers to improve the performances.

The as-prepared PP piezoelectret films showed anti-resonance frequencies at about 420 kHz in thickness direction, and the corresponding elastic moduli were around 1.4 MPa. Their piezoelectric $d_{33}$ coefficients could reach up to 320 pC/N at 2 Hz, which were two magnitudes larger than their $d_{31}$ and $d_{32}$, and decayed to 260 pC/N when the frequency of driving force was increased to 300 Hz, since their elastic moduli were increased. The acoustic tests demonstrated that the sensitivity level of piezoelectret films was quite stable in the frequency range from 0.1 to 1 kHz, and it was about -60 dB (1 mV/Pa, ref. 1 V/Pa) at 1 kHz. The sensitivity increased significantly to -54 dB when the frequency was further increased to 10 kHz, which was possibly caused by acoustic diffractions, and then dropped down to around -60 dB. With some proper packaging technology and gain, the fabricated microphones with single-layer piezoelectret film showed appreciable sensitivity and frequency response, and could be prominent candidates for acoustic applications, as shown in Fig. 1. In addition, by stacking two piezoelectret layers in series connection, a 6 dB increase in sensitivity was achieved on the present packaged microphones.

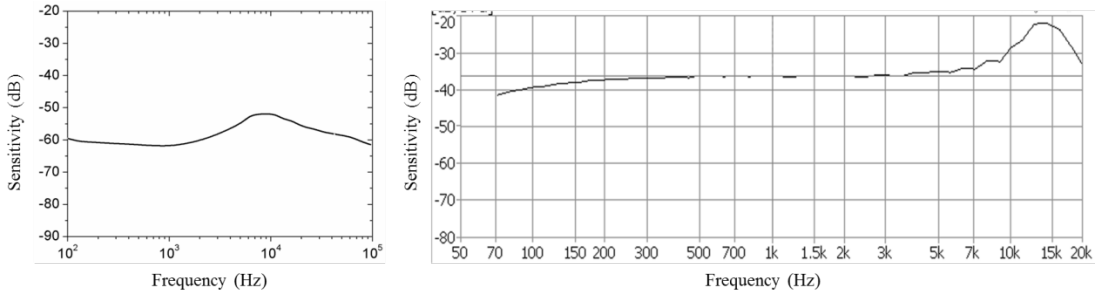


Fig. 1. The sensitivity-frequency dependence of a piezoelectret film (left) and a packaged single-layer piezoelectret microphone with gain (right). The reference sensitivity was 1 V/Pa.

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