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Designing Piezoelectric Audio Systems Using Polymer Polyvinylidene Fluoride

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Abstract

We develop a method to fabricate a flexible thin film audio systems using polyvinylidene fluoride(PVDF). The system we designed showed the properties of increased flexibility, transparency, and sound pressure levels. As an input port of two terminals, transparent oxide thin film with a low resistivity is adopted. In order to provide dielectric insulation, a transparent insulating oxide thin film is coated to obtain double-layered structure. In the range of visible light, the output from the output of the system showed a increased and improved sound pressure level. The piezoelectric polymer film of PVDF is used to produce mechanical vibration due to the applied electrical voltage signal. An analog electric voltage signal is transformed into sound waves in the audio system.

Keywords : *Piezoelectric materials, ITO/PVDF, thermophone, Sound pressure level(SPL).*

1. Introduction

With the development of electronic and electrical technology in recent years, various kind of devices and equipments are produced. A light-emitting devices utilizing electrical signals, memory devices for storing information, wireless communication devices for the near and far field, and sensor elements are important building blocks used in display devices, cell phones, MP3 players, and digital cameras. Such devices have been designed on a solid printed circuit board. In doing so, the reliability, miniaturization, light-weight, thin-thickness, integration, and portability are main technical concerns. In order to develop devices of miniaturization, light-weight, and thin-thickness a printed circuit board is used. The piezoelectric polymer film of polyvinylidene fluoride (PVDF) is used to produce mechanical vibration due to the applied electrical voltage signal. An analog electric voltage signal is transformed into sound waves in the audio system. Conductive molecular particles of MEH-PPV/PVDF are melt into a solvent [1]. The solvent are coated on the surfaces of PVDF by roll-to-roll coating or conducting mechanism. We introduced a protective membrane to safeguard the electric leakage from the surface of conductive molecular coating material. The thickness of coating material is about a three to four hundreds micrometers. Our system is designed in hybrid format so that the audio speaker is adopted. It is flexible and light-weight. It can be operated with a low level of

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voltage.

2. System configurations

A speaker is a system which produces acoustic waves through electromechanical operations. It transforms electronic signals into audible sound signals. At the end of the 19th century, Preece and Braun et al. reported that when an ac current passed through a very thin metal foil, the thermophone produced sound. But the thermophone emitted extremely weak sound [2]. Piezoelectricity is the ability of some materials to generate an electric field or electric potential in response to applied mechanical stress. The piezoelectric effect is understood as the linear electromechanical interaction between the mechanical and the electrical state in crystalline materials with no inversion symmetry [3]. In Fig.1, our device configuration of flexible film for audio system is shown. It is composed of piezoelectric polymer film, two transparent conductive oxide films on both sides, and two transparent conductive insulating films on both of outermost spaces [4].

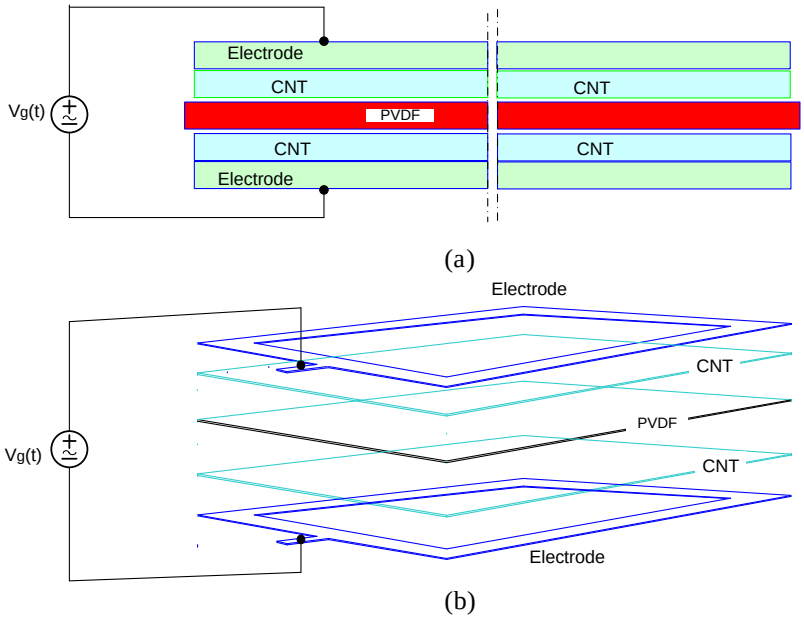
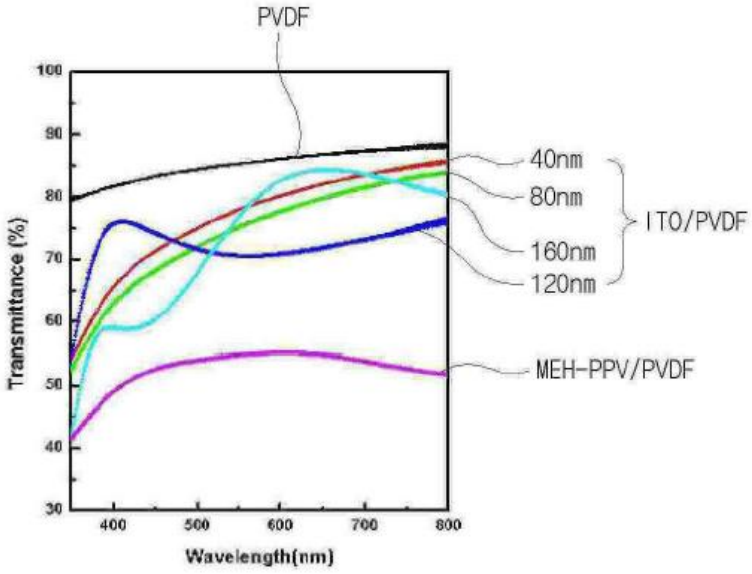


Figure 1. Configuration of flexible; film audio system

(a)Side view; (b) Bird'd eye view

3. Manufactured output of system

In Fig.2 (a), the comparison of transmittance of ITO/PVDF and MEH-PPV/PVDF for the different thickness of law material of ITO and PVDF is shown. In Fig.2 (b), the audio system designed for commercial availability is shown. The coating material being often used is indium tin oxide (ITO, or tin-doped indium oxide). It is a solid solution composed of indium oxide (In_2O_3) and tin oxide (SnO_2) [5]. The typical constitutive ratio is 90% of In_2O_3 and 10% of SnO_2 by weight. It is transparent and colorless in thin layers while in bulk form it is yellowish to grey. In the infrared region of the spectrum it is a metal-like mirror [6]. The transparent conductive insulating films on both of outermost spaces is made from chemical compound In_2O_3, ZnO, and SnO_3. The ratio of compound shows different output of sound. The thickness of 350-700 nanometer of transparent conductive oxide films showed to have transparency of 80 % . The thickness of 550 nm showed transparency of 84 %.



(a) (b)

Figure 2. (a) Comparison of transmittance of ITO/PVDF and MEH-PPV/PVDF for the different thickness of law material of ITO and PVDF. (b) Audio system designed for commercially available.

4. Conclusions

In this paper, by adopting piezoelectric polymer film of polyvinylidene fluoride (PVDF), we designed a system of audio actuator system in order to obtain a sound as an output of the system. By comparing the operating properties of transmittance of ITO/PVDF and MEH-PPV/PVDF, we could design a real audio system. As operating parameters of the output SPL, the ratio of chemical compound, showed different transparency of the film. Our future work includes the circuit model of the system in order to drive the optimal parameters for the increased sound pressure level (SPL).

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