Microfiber Attached Polymer Diaphragm as a Versatile Microphone

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An optical microphone consisting of a microfiber attached to a polymer diaphragm is presented. The measured acoustic sensitivity of the microphone is 856.2 mV/kPa and its working range is up to 2500 Hz. The sensitivity and working range of this microphone setup can be tailored easily as per the requirement.

Acoustic sensors have numerous applications in the fields of defence, biomedical and bio-acoustics [1]. Presently most of the commercially available microphones are electro-mechanical or piezo-electric devices which have their limitations in terms of sensitivity, rang, size and non-immunity to electromagnetic signals. Recently, fiber acoustic sensors have attracted a lot of attention for the advantages compared with traditional technologies, such as small size, light weight, immunity to electromagnetic interference and the ability of multiplexing.

In this paper, we propose an acoustic sensor consisting of a microfiber attached to a polymer diaphragm. The sensitivity and working range of this microphone setup can be tailored easily as per the requirement.

The schematic of the proposed optical microphone setup is shown below in Fig. 1. It consists of a circular polymer diaphragm of 15 mm diameter and 90 μm thickness. A single mode fiber (SMF) is tapered using flame and technique to fabricate a microfiber of 16 μm diameter and 12 mm length [2]. The shortened end of the microfiber is carefully attached at the centre of the polymer diaphragm using commercial adhesive. The pigtailed end of microfiber is placed on top of a computer controlled 3-axis stage. The 3-axis stage is used to adjust the vertical and horizontal distance between the two ends of the microfiber respectively at 9 mm and 3 mm.

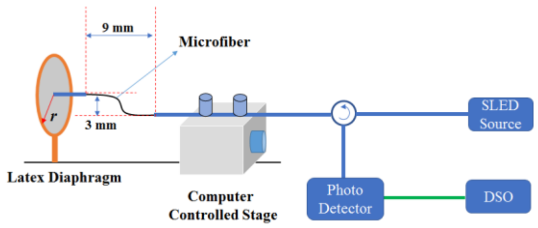

Fig. 1. Schematic of the microfiber based optical microphone.

The pigtailed end is connected to a circulator, the other two ports of the circulator are connected to SLD source and photodetector. Light from SLD source is guided towards the microfiber section and then gets reflected from the cleaved end of the fiber which is attached to the polymer diaphragm. The reflected light again travels through the microfiber section and then it is guided towards the photodetector. Now when the acoustic signal is applied on this microphone setup, it deforms the diaphragm and the maximum deformation is at the centre of the diaphragm where the microfiber is attached. This leads to bending of the microfiber and subsequently the photodetector output changes in accordance with the intensity and frequency of the applied acoustic pressure. In Fig. 2, the time domain signal recorded by the photodetector and its FFT are shown for an applied acoustic signal at 500 Hz. The FFT shows a sharp peak of 59 dB at 500 Hz which confirms that the proposed optical microphone accurately detects the acoustic signal. The measured acoustic sensitivity of the microphone is 856.2 mV/kPa and its working range is up to 2500 Hz. The working range and sensitivity can be changed by adjusting the vertical and horizontal distance between the two ends of the microfiber.

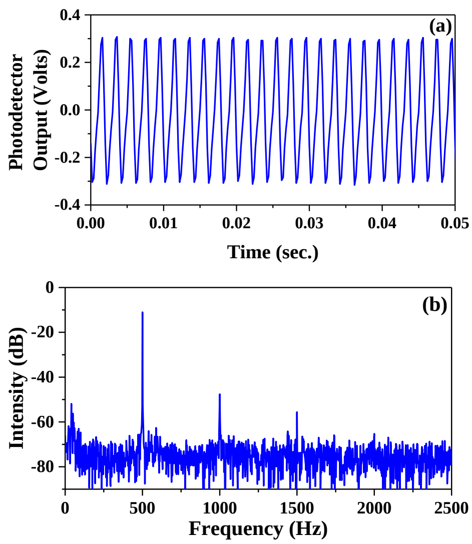

Fig. 2 (a) Time domain signal recorded by photodetector and (b) its FFT for applied acoustic signal at 500 Hz.

In conclusion, we proposed and demonstrated an optical microphone consisting of a microfiber attached to a polymer diaphragm. Experimentally we verified that the average sensitivity of the proposed acoustic sensor is 856.2 mV/kPa over a frequency range of 0-2500 Hz.

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References

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[2] S. Dass and R. Jha, *IEEE Photonics Technol. Lett.*, vol. 28, no. 1, pp. 31–34, 2016.