Piezoelectric enhancement of an electrospun AlN-doped P(VDF-TrFE) nanofiber membrane

Jiang Yang, Guodong Zhu*
gdzhu@fudan.edu.cn
Department of Materials Science, Fudan University,
Shanghai 200433, China

Introduction

Nowadays both the internet of things and wearable electronics are flourishing with the advent of the global 5G era. It's a great challenge to power a large number of sensors without environment pollutions. Fortunately, piezoelectrets are one kind of material that can convert mechanical energy into electrical energy. PVDF-based piezoelectric polymers are attracting increasing attention due to their advantages of flexibility, ultralight weight and good biocompatibility.

Herein, we reported the electrospinning fabrication of high-performance AlN-doped P(VDF-TrFE) nanofiber membranes for wearable sensing[1]. Our work indicated that a very small amount of AlN doping could effectively enhance both the perpendicular and transverse piezoelectric performance.

Results and discussion

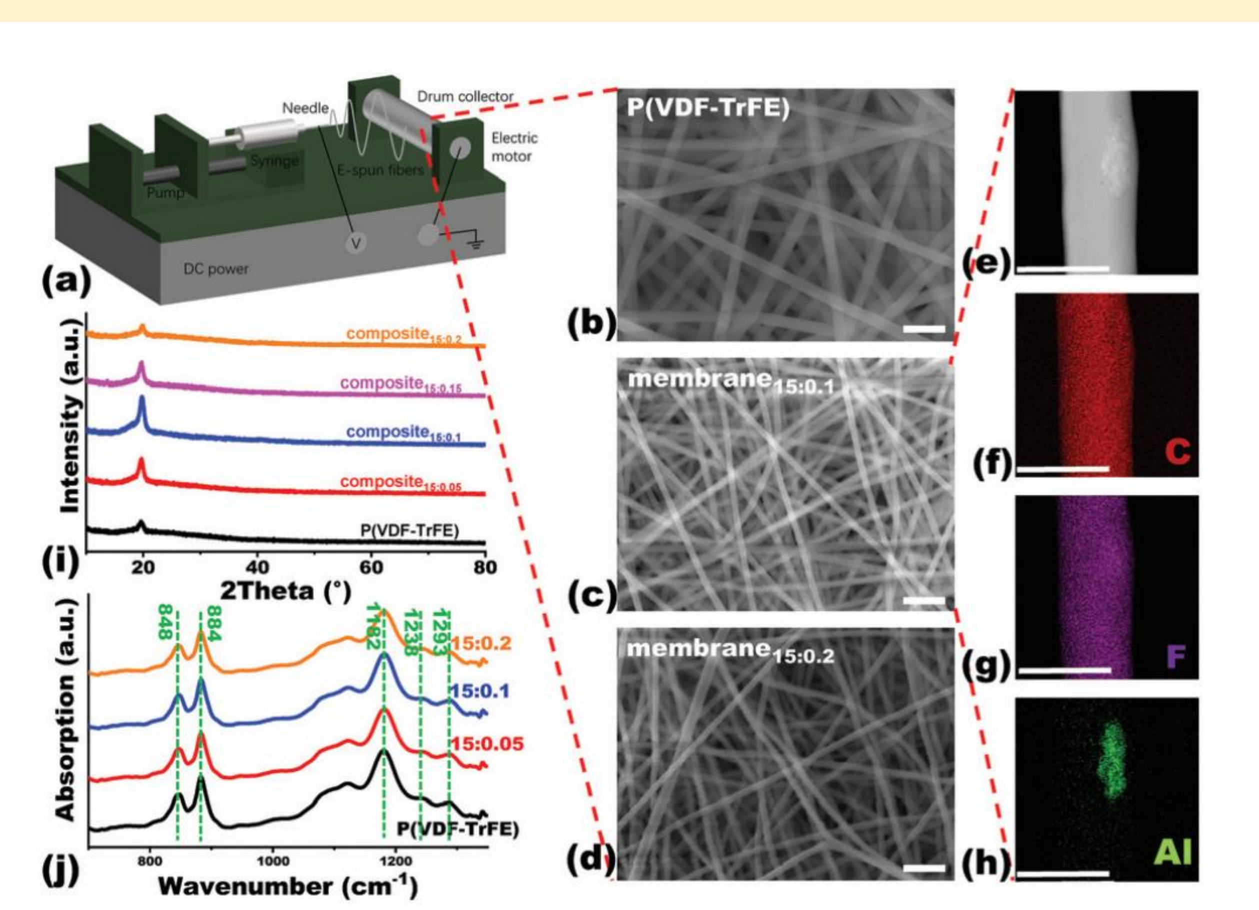

Fig.1 Electrospinning of AlN doped P(VDF-TrFE) nanofibers.

We prepare the AlN-doped P(VDF-TrFE) nanofibers through electrospinning technology.

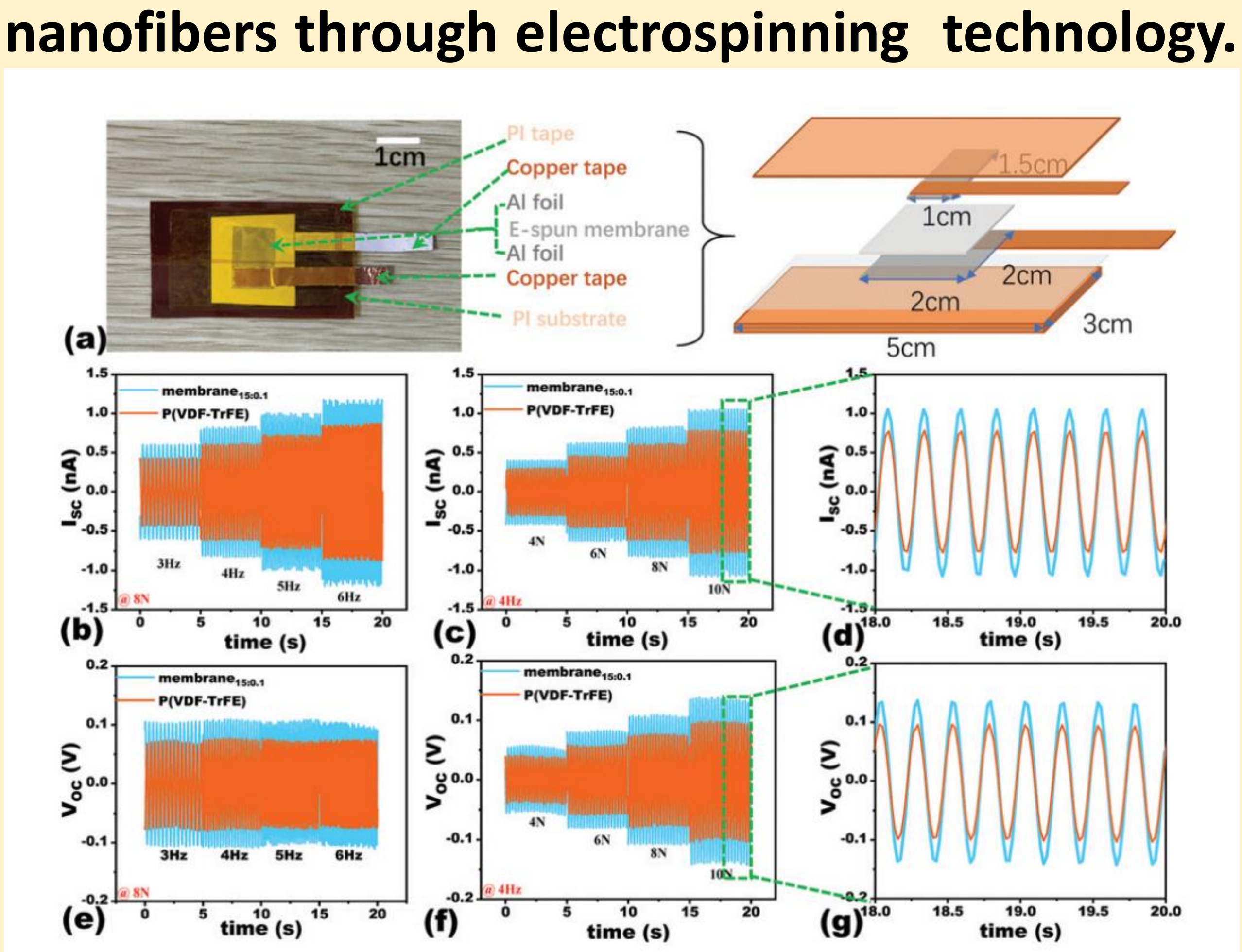

Fig.2 Electrical responses of both the AlN-doped nanofiber membrane$_{15:0.1}$ and the neat one.

Under perpendicular testing, the electrical output of 0.1 wt% AlN-doped P(VDF-TrFE) are higher than that of the neat one.

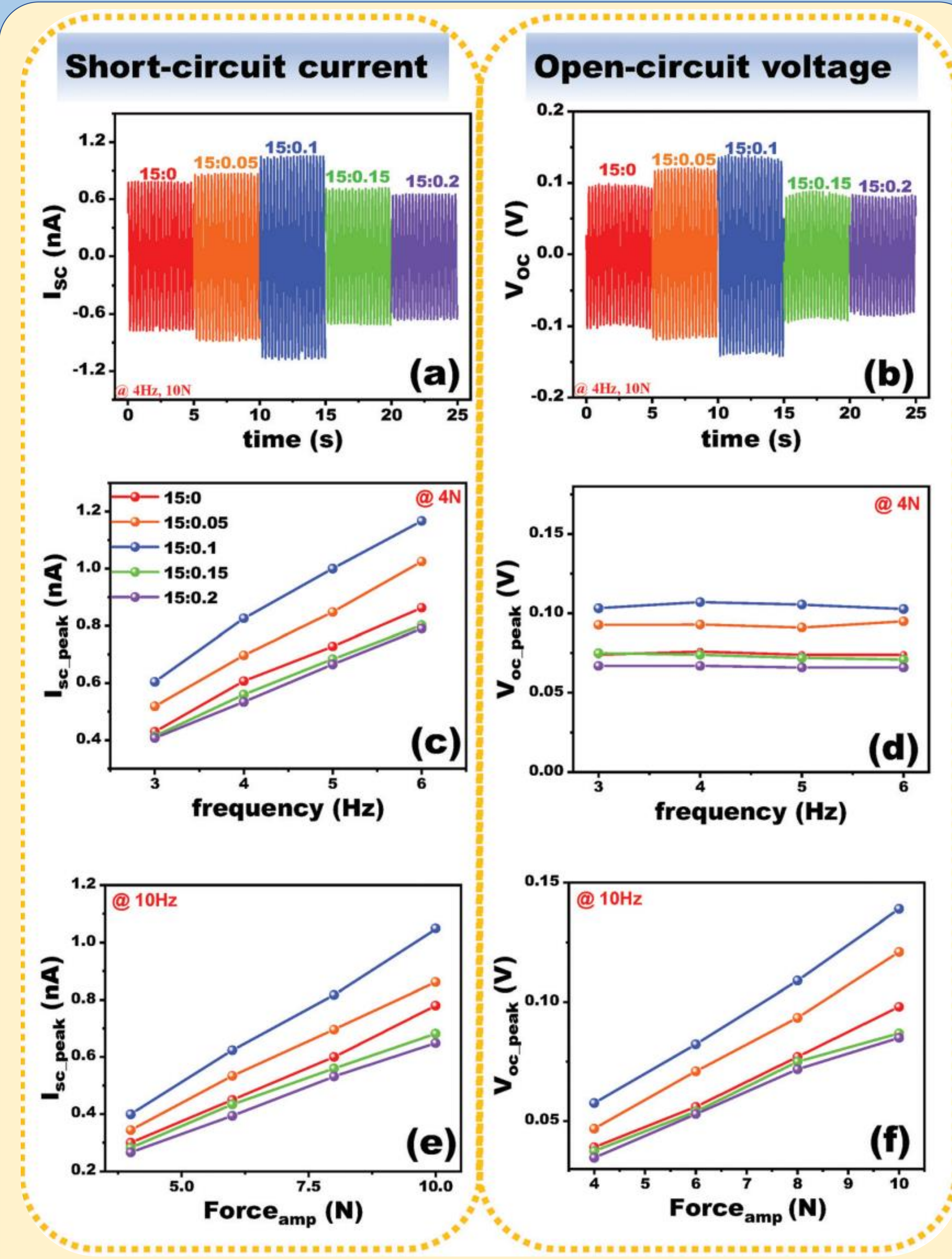

Fig.3 The perpendicular piezoelectric property.

The current increases with frequency and force, but the voltage remains stable as the frequency changes.

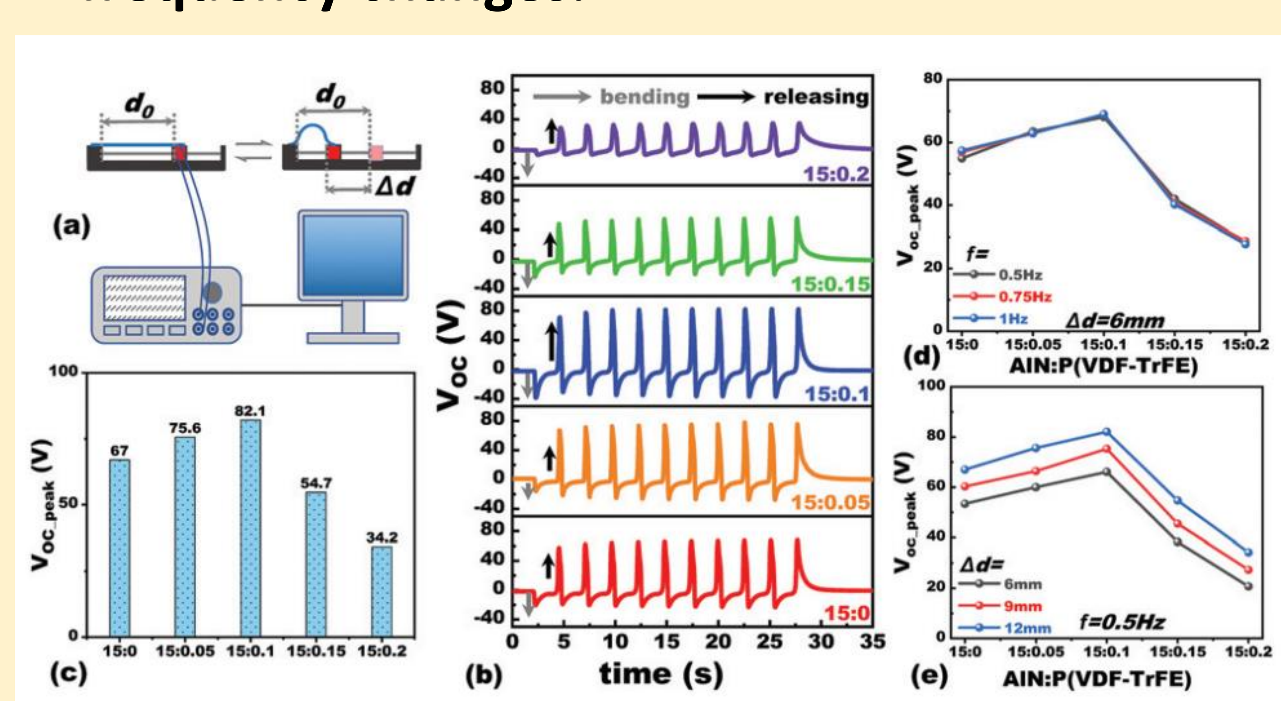

Fig.4 The transverse piezoelectric property.

Under transverse testing, the 0.1wt% AlN-doped nanofibers show the greatest output 80.7V.

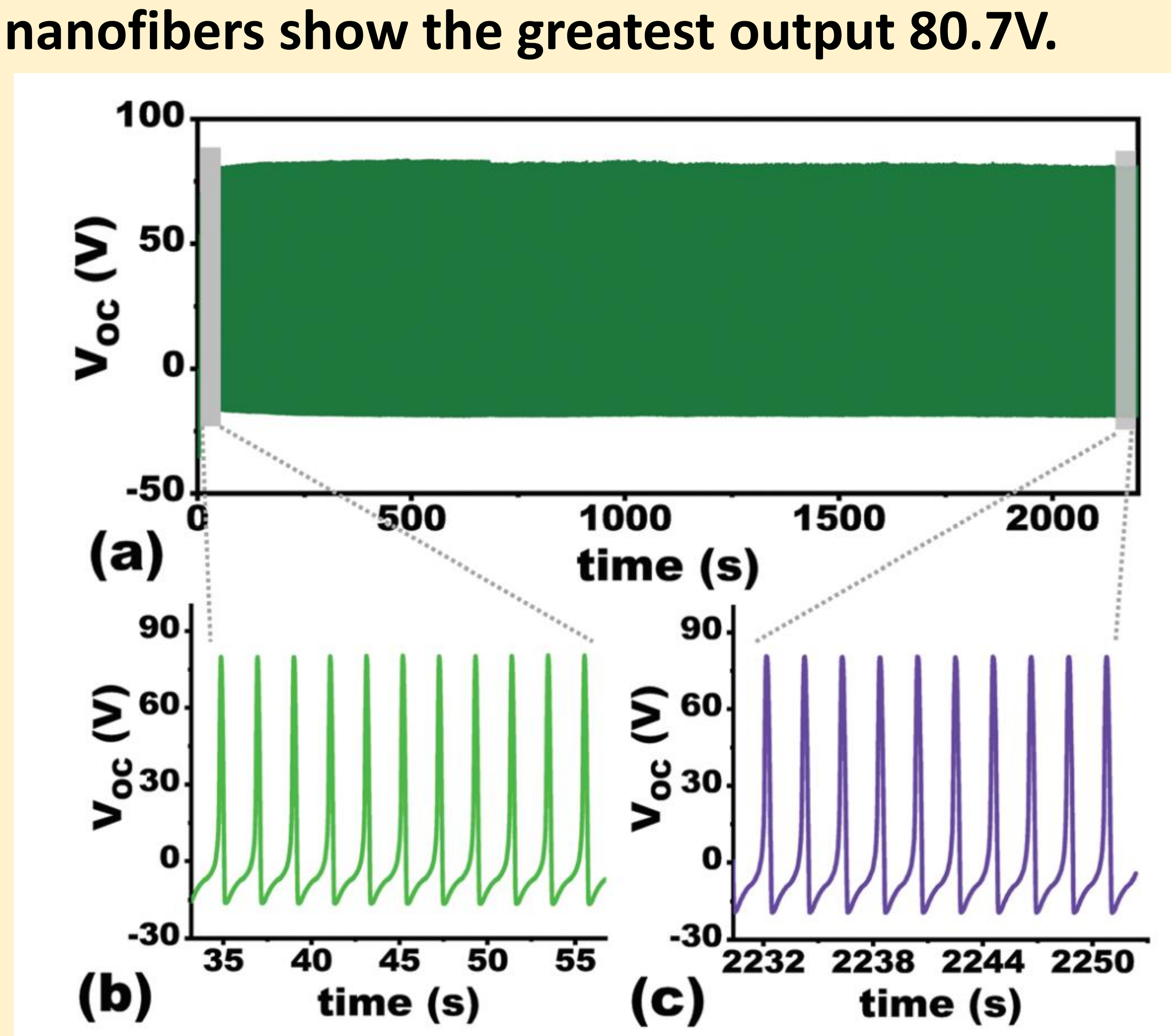

Fig.5 Endurance of the open-circuit voltage response.

As for endurance, the output voltage stays stable during 1100 cycles.

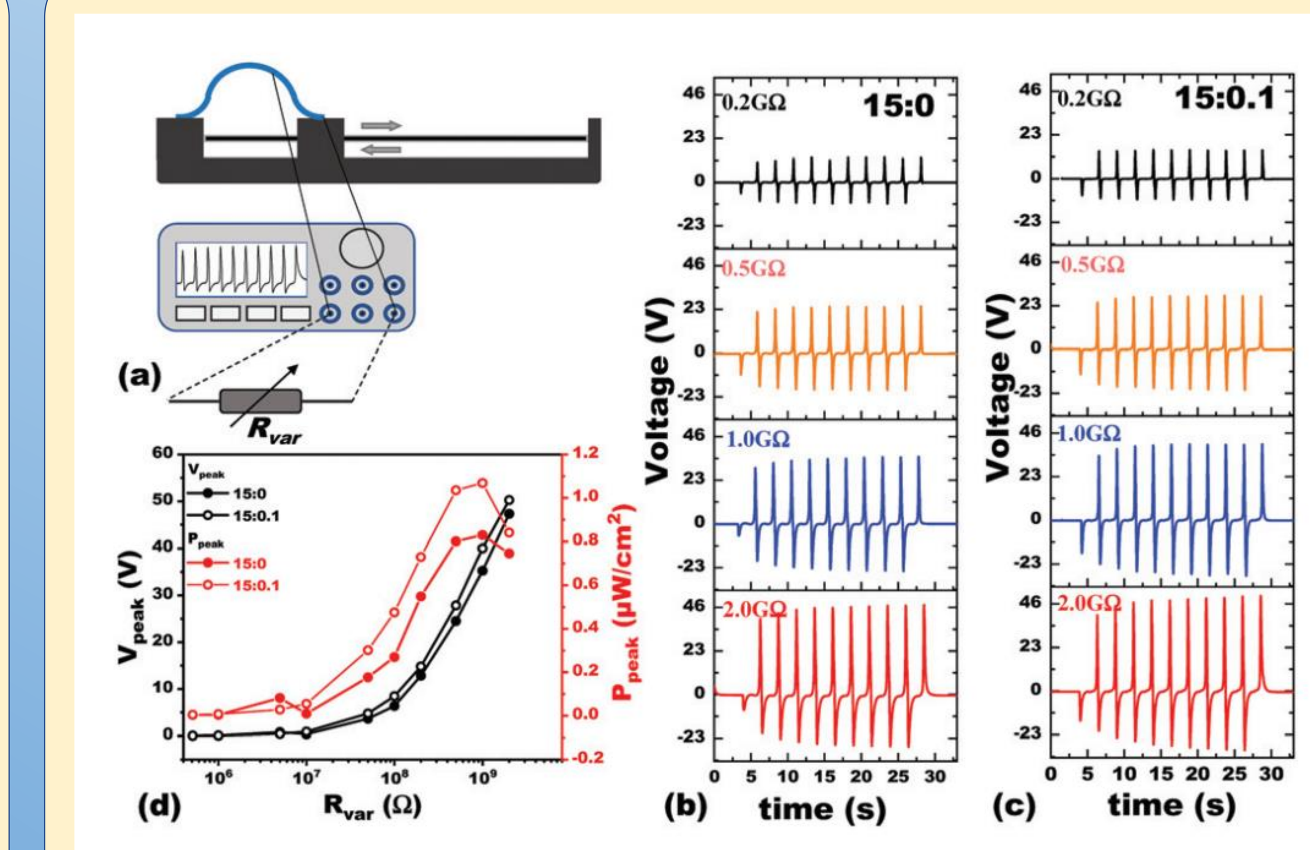

Fig.6 Mechanical energy harvesting of the membranes.

An optimal external load of 1.0 GΩ results in a maximum Ppeak value of 0.83 mW/cm^2 for the neat P(VDF-TrFE) membrane and 1.07 mW/cm^2 for the membrane$_{15:0.1}$, corresponding to a 29% enhancement.

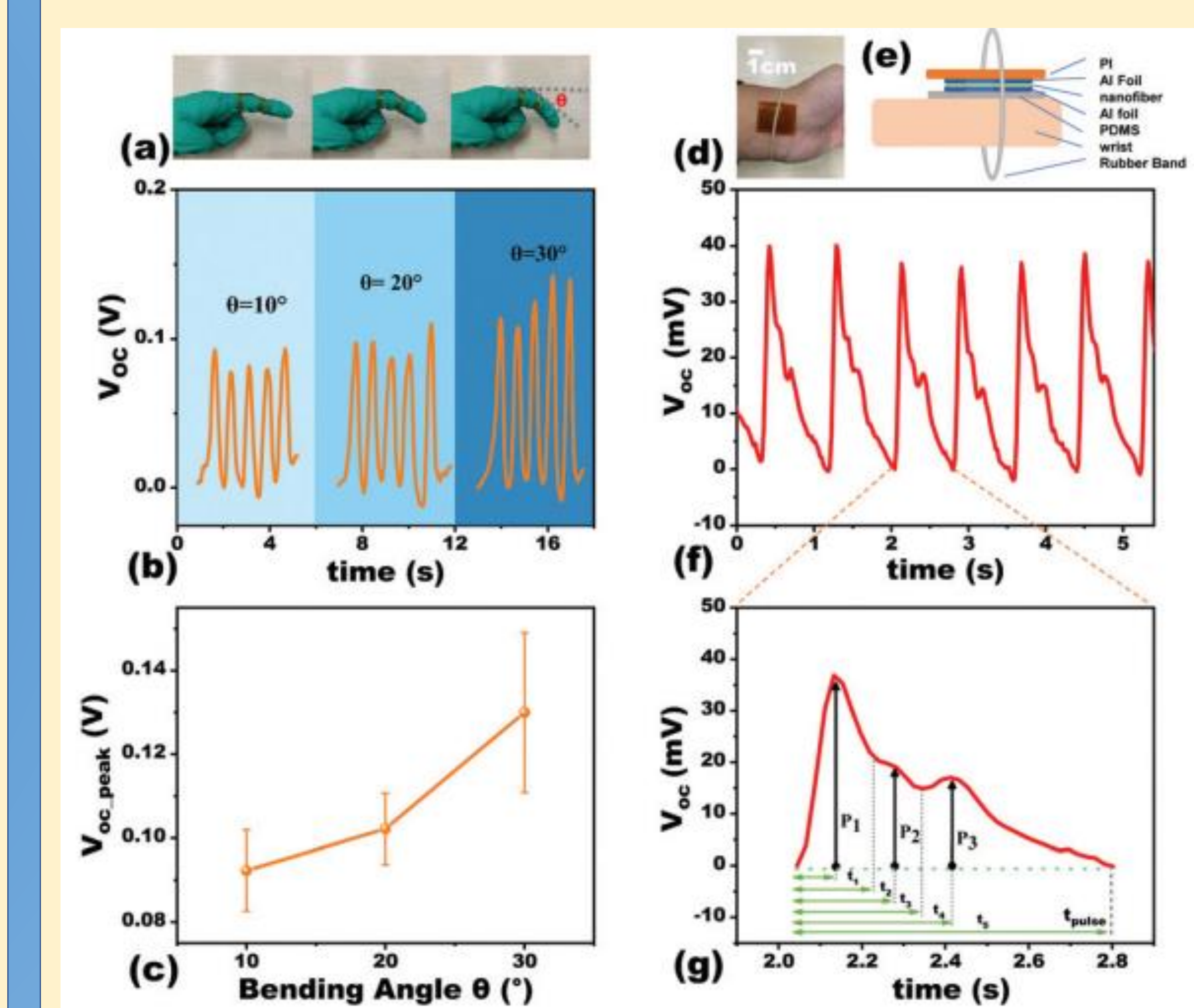

Fig.7 Application of the nanofiber membrane$_{15:0.1}$

Wearable sensor can be used to detect the finger bending and the pulse.

Conclusion

Our work indicated that a very small amount of AlN doping could effectively enhance the piezoelectric performance of P(VDF-TrFE), and the piezoelectric nanocomposite membrane was further developed for wearable and flexible electronics.

Reference

[1] Jiang Yang, Fan Xu, Hanxiao Jiang, Conghuan Wang, Xingjia Li, Xiuli Zhang and Guodong Zhu, "Piezoelectric enhancement of an electrospun AlN-doped P(VDF-TrFE) nanofiber membrane," *Mater. Chem. Front.*, 2021,5,5679-5688