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## **Supporting Information**

Fig S1. Optical picture of electrode dispersion and electrode film



Fig S1a was the picture of PEDOT:PSS and 30% M-PEDOT:PSS electrode dispersion. uniform dispersion was obtained through stirring and bath sonication with no aggregation and sedimentation after 10 days. The prepared electrode film by casting method was shown in Fig S1b. The 30% M-PEDOT:PSS composite electrode performed highly uniform morphology as well as pristine PEDOT:PSS electrode, which indicates that the carboxylic MWCNTs was uniformly dispersed in the PEDOT:PSS.

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Table S1. Electrical conductivity properties of electrode

electrode	PEDOT:PSS	10%	20%	30%
		M-PEDOT:PSS	M-PEDOT:PSS	M-PEDOT:PSS
Thickness (µm)	24	25	27	28
conductivity (S·c m-1)	4.64	40.17	91	153.75



Fig S2. Stress as a function of strain for the actuator

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Table S2. Mechanical properties of electrode and actuator membra
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	Tensile modulus(MPa)	Tensile strength(MPa)	Elonggation(%)
PEDOT:PSS	127.64	13.54	20.93
10% M-PEDOT:PSS	286.09	25.14	14.80
20% M-PEDOT:PSS	608.38	32.29	12.13
30% M-PEDOT:PSS	918.27	54.89	11.27
PEDOT:PSS/TPU:IL/PEDOT:PSS	45.71	4.06	24.03
10% M-PEDOT:PSS/TPU:IL/10% M- PEDOT:PSS	64.92	4.91	11.20
20% M-PEDOT:PSS/TPU:IL/20% M- PEDOT:PSS	71.28	6.90	15.70
30% M-PEDOT:PSS/TPU:IL/30% M- PEDOT:PSS	82.18	7.75	15.93

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**Fig S3.** Bending actuation performances of the PEDOT:PSS and 30% M-PEDOT:PSS electrode based actuators under different driving voltage at 0.1 Hz.