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| 논문원고접수 |

2020년 12월 14일(월) ~ 2021년 1월 13일(수)

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| 초록 및 논문접수처 |

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| 논문범위 |

1. Materials, Fabrication, Packaging and Simulation Technologies
2. Micro/Nanofluidics
3. Bio/Medical Micro/Nano Devices
4. Physical and Mechanical Micro/Nano Sensors and Systems
5. Chemical and Environmental Sensors
6. RF/Optical Devices
7. Micro/Nano Energy and Power Devices
8. Soft, Flexible and Printed Devices

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논문 No.	Journal Title	First Author	Corresponding Author	Presenting Author	Organization
FP-4-06	Detection of specific blood cancer mutations using DNA-dCas9 binding sample mobility changes	이상준	김성재	이상준	서울대학교
FP-4-07	Bypass 구조의 폐수 찌꺼기 실시간 함수율 측정센서 제작	김재민	고정상	김재민	부산대학교
FP-4-08	마름모 단면을 가진 미세채널 내 점탄성 유체에서 나노입자 탄성-관성 집중 현상	권주용	조영학	권주용	서울과학기술대학교
FP-4-09	등변육각형 단면 형상의 미세 채널 내에서의 입자 집중 현상	김의환	조영학	김의환	서울과학기술대학교
FP-4-10	미세 유체 순환을 활용한 MEMS 기반의 공기 중 금속 입자 실시간 측정 시스템	윤종서	김용준	윤종서	연세대학교
FP-4-11	용액 및 온도구배를 이용한 나노채널내 확산삼투 기반 이온 전달 현상의 제어 및 분석	이종완	김태성	김동준	울산과학기술원
FP-4-12	Combined Inertial and Temperature Effects Generated by 3D Microfluidics Device for Continuous Particle Separation	이경훈	김태성	이경훈	울산과학기술원
FP-4-13	초소수성 하이드로젤 마이크로니들 표면에서의 얼리 바운싱	하치욱	이충엽	하치욱	경희대학교
FP-4-14	미세유체 기술을 이용한 PS-b-PMMA의 균일한 크기의 전도성 마이크로 입자 제조	김영덕	고정상	김영덕	부산대학교
FP-4-15	미세유체칩을 이용한 바이셀의 연속적인 합성 및 합성 리피드 멤브레인의 물리 화학적 특성 분석	강봉수	곽문규	강봉수	경북대학교
FP-4-16	Preparation of porous microsphere using mixing in microdroplet in microfluidic device	한지환	김규만	한지환	경북대학교
FP-4-17	수용액 이상계 액적을 이용한 크기 기반 나노입자 분리 (Size-based separation of nanoparticles via aqueous two-phase system droplets)	정재훈	박재성	정재훈	포항공과대학교
FP-4-18	역전기삼투 공정 장치 내 음극에서의 수소이온 생성층 특성 분석	조인희	곽노균	조인희	한국생산기술연구원
FP-4-19	Active Control of Solutal Marangoni Effect using Ultrasound-induced Heating	차범석	박진수	차범석	전남대학교
FP-4-20	원형 채널의 돌출 팁 구조에 따른 마이크로 액적 크기 변화 Micro droplet size changes depending on protruding tip of 3D circular channel	이찬주	황용하	이찬주	고려대학교
FP-4-21	이온농도분극 현상을 이용한 Caviar 추출물 대용량 분리농축 장치 개발	홍성준	김성재	홍성준	서울대학교
FP-4-22	Fabrication of Electroplated Nickel Hollow Microneedle Arrays	동조위	박우태	동조위	서울과학기술대학교
FP-4-23	Integrated Microfluidic chip (HO-MOFF) for Rapid and Selective Isolation of Tumor Derived Exosomes to Evaluate Metastatic Risk in Breast Cancer	곽호경	정효일	곽호경	연세대학교
FP-4-24	액적 미세유체에 의한 순환종양세포-호중구 클러스터 형성을 위한 세포의 관성력 보조 페어링	박준현	현경아	박준현	연세대학교
FP-4-25	A disposable capacitive electrical droplet measurement based on film-chip technique	김준형	조형석	한기호	인제대학교
FP-4-26	분자 진단을 위한 광섬유 국소화 표면 플라즈몬 공명 센서 칩의 제작 및 측정	김형민	이승기	김형민	단국대학교
FP-4-27	높은 민감도를 갖는 가스 검출용 표면 플라즈몬 공명 센서의 설계	이연수	김정무	이연수	전북대학교
FP-4-28	종이기반 마이크로유체 미생물 연료전지 전력량 향상을 위한 연구	김진용	안유민	김진용	한양대학교
FP-4-29	Piezoelectric nanogenerator based on lead-free flexible PVDF-barium titanate composite films for harnessing biomechanical energy	Sahu Manisha	김회준	Sahu Manisha	대구경북과학기술원
FP-4-30	Microfluidic Device Based Flexible Triboelectric Generator for Energy Harvesting and Self- Powered Fluidic Sensor Applications.	Karthikeyan Munirathinam	이동원	Karthikeyan Munirathinam	전남대학교
FP-4-31	마이크로 유체 시스템에서의 다중 산화환원 유기 전해질의 무막 산화환원 전지 연구	박형주	김성재	박형주	서울대학교
FP-4-32	Micro-Cilia Integrated Single Electrode Mode Triboelectric Nanogenerator for Scavenging Ambient Mechanical Energy	서정연	김회준	서정연	대구경북과학기술원

Microfluidic Device Based Flexible Triboelectric Generator for Energy Harvesting and Self- Powered Fluidic Sensor Applications.

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에너지 수확 및 무전원 센서 활용을 위한 마이크로유체 기반의 마찰전기발전기

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Abstract

Microfluidic devices with flexible and energy harvesting platforms have a strong influence on wearable electronics and self- powered sensors. This paper reports a liquid metal-based single electrode triboelectric generator (SETEG) for energy harvesting and self-powered fluidic sensor applications. The SETEG is made on the PDMS substrate by injecting liquid metal Galinstan into the micro channels. Here, two electrodes are placed parallel to each other, forming a channel for liquid flow between them. When the liquid flow between the electrodes, an alternating (AC) power is generated due to the conjunction of triboelectrification and electrostatic induction. We fabricated SETEG in three different sizes and demonstrate its applicability for wide range of power generation. The device is also tested for self-powered sensor applications by monitoring the viscosity of aqueous sugar solution. We believe that the SETEG could provide a benchmark for flexible energy harvesting and self-powered sensor applications.

Keywords: ***Triboelectric generator, Energy harvesting, Flexible electrode, Galinstan, self- powered sensors.***

1. Introduction

With the rapid increase in development of microfluidic device as portable electronics and wireless sensor networks, they found their efficient use in day to today applications such as, personal health care, flexible electronics and house hold applications. However, the advance in microfluidic devices put forward severe challenges on the traditional power sources. Since the introduction of microfluidic devices, various energy harvesting technologies have been proposed that rely on electromagnetic, piezoelectric, and electrostatic induction mechanisms. Recently, triboelectric nanogenerators (TENGs) is achieving a rapid progress in energy harvest technologies. TENGs convert mechanical energy into electricity based on the conjunction triboelectrification and electrostatic induction. TENGs integrated into microfluidic devices have become promising candidate for energy harvesting and self-powered sensor applications due to their simple fabrication process and expected size.

Until now, various liquid metal-based TNEGs have been reported, including liquid-metal based triboelectric nanogenerator for wearable electronics [1], liquid metal-based electrode for high performance triboelectric nanogenerator [2], liquid-metal based triboelectric nanogenerator for streatchable electronics [3]. However, the energy harvesting mechanism of most of the reported liquid metal-based TNEGs are based on movement and contact of physical electrodes limits their potential applications in flexible electronics, portable energy harvesting devices and bulk power generators

In this work, we report a SETEG for energy harvesting and self-powered fluidic sensor applications. The flexible SETEG is designed based on single electrode model and fabricated by injecting Galinstan into the PDMS microchannel. When the liquid flow between the electrodes, an alternating (AC) power is generated due to the conjunction of triboelectrification and electrostatic induction. The power generated by the SETEG makes the device a strong candidate for self-powered sensor applications.

2. Methods and Materials

2.1 Working principle

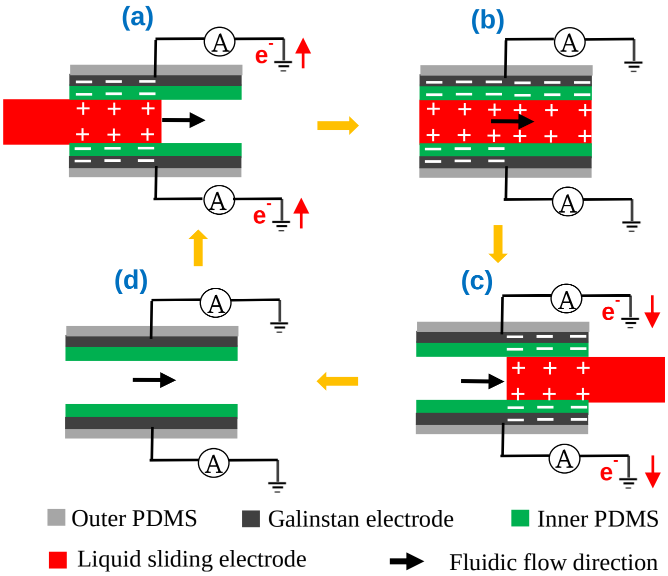

Fig.1 shows the working principle of the triboelectric generator

Fig.1 shows the energy transduction mechanism of the SETEG. Initially, due to the large difference in triboelectric polarity, PDMS attracts electrons from the ionic liquid. These negative triboelectric charges on the PDMS induce positive charges on the Galinstan electrode from the ground as induced charges. Once the ionic liquid approaches the Galinstan electrode, the positive triboelectric charges in the ionic liquid will drive electrons to flow from the ground to the Galinstan electrode, as shown in Fig.1(a). When the liquid is aligned with the electrode, the negative charges reach the maximum quantity on the Galinstan electrode, as shown in Fig.1(b) III. As the liquid starts to move away from the electrode, the induced electrons will flow back to the ground, as shown in Fig.1(c). Finally, the device will return to its original state in Fig. 1(d) as the liquid move away from the electrode. Consequently, as the ionic liquid passes through, an alternating flow of electrons occurs between the Galinstan electrode and the ground, which is the electric signal for indicating the approaching and leaving of the liquid to/from the electrode.

2.2 Fabrication of energy harvesting microfluidic device

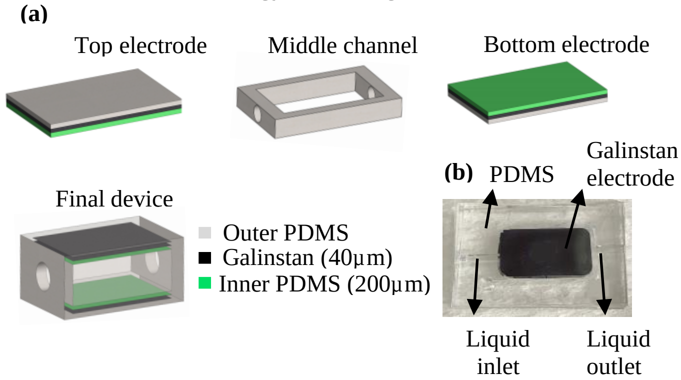

Fig. 2. (a) Schematic of fabrication of the SETEG (b) image of the fabricated device.

The fabrication process of SETEG is shown in the Fig. 2(a). The proposed microfluidic device has three layers (Top electrode, Middle channel, Bottom electrode) made of PDMS substrate After the fabrication, they are bonded together using oxygen plasma treatment. Next, Galinstan is injected via input hole to form the capacitor plates on the PDMS substrate. Finally, the inlet and outlet holes are closed. Fig. 2(b) shows the image of fabricated device.

2.3. Results

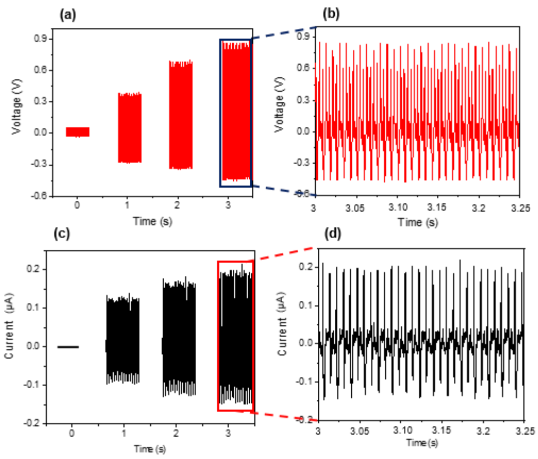

Fig. 3 a) Rise in voltage generated by the device b) peak voltage c) rise in current generated by device d) peak current.

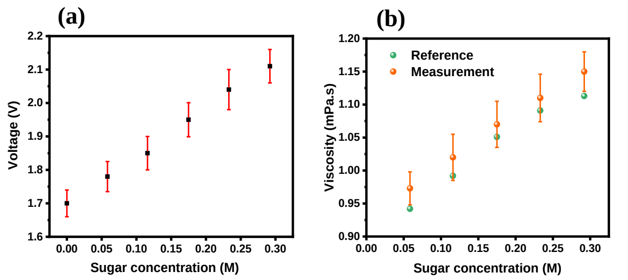

Fig. 4 a) Voltage variation with different concentration of aqueous sugar solution (b) comparison of the experimental result with the reference.

To characterize the performance of SETEG, an experimental setup with microfluidic device, syringe, syringe pump, pre-amplifier, oscilloscope, inlet and outlet tube was made. Then the liquid is passed between the electrodes and the corresponding voltage and current was measured as shown in the Fig.3. The device is also tested for self-powered sensor applications by monitoring the viscosity of aqueous sugar solution (2 to 10 grams of sugar in DI water). The corresponding result is shown in Fig. 4(a) and compared with the reference in Fig. 4(b).

3. Conclusion

Here, we reported SETEG for energy harvesting and self-powered fluidic sensor applications. The flexible SETEG was designed based on single electrode model and fabricated by injecting Galinstan into the PDMS microchannel. When the liquid flow between the electrodes, an alternating (AC) power is generated due to the conjunction of triboelectrification and electrostatic induction. The power generated by the SETEG was used to demonstrate the self-powered fluidic sensor applications.

Acknowledgment

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