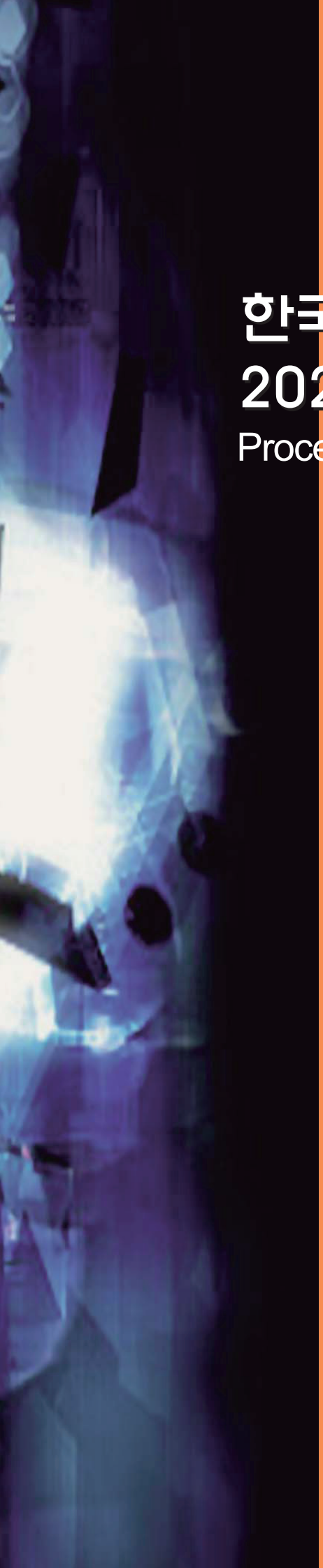

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KSPE Korean Society for Precision Engineering

Korean Society for Precision Engineering

23SPP08-040 고효율 가역 건식접착소재 개발을 위한 형상기억고분자의 프로그래밍 온도 제어 기술
박한준(경북대학교), 곽문규(경북대학교)

23SPP08-041 마이크로/나노 구조 코팅의 마찰 및 마모 특성에 관한 연구
이성준(조선대학교), 김창래(조선대학교), 권혜민(조선대학교), 김태억(조선대학교)

23SPP08-042 롤투롤 그라비어 프린팅 방식의 금속산화물 기반 트랜지스터 생산을 위한 저온 EDUV 어닐링 공정조건 연구
신재학(건국대학교), 이동진(건국대학교), 이호림(건국대학교), 진신양(건국대학교)

23SPP08-043 유연 소자의 기계적 신뢰성을 위한 알루미늄 박막의 기계적 물성 측정
최원(KAIST), 김택수(KAIST), 백수연(KAIST), 오승진(KAIST), 최경철(KAIST)

23SPP08-044 FPSC 효율 향상을 위한 형상기억고분자 활용 나방눈 모사 마이크로/나노 복합구조 무반사 필름 제작
이가인(경북대학교), 곽문규(경북대학교)

23SPP08-045 미세플라스틱 표면 흡착성 독성물질 검출을 위한 표면탄성파 기반 표면증강 라만분광 시스템 개발
안형민(한국생산기술연구원), 김광복(한국생산기술연구원), 이창기(한국생산기술연구원)

23SPP08-046 EUV 마스크 검사 장비의 회전 오정렬 보상을 위한 θz 스테이지 설계
문제욱(한국생산기술연구원), 이학준(한국생산기술연구원)

23SPP08-047 간단한 폴리머 패키징을 활용한 전도성 하이드로겔 스트레인 센서
최종안(서울과학기술대학교), 표순재(서울과학기술대학교), 정진구(서울과학기술대학교), 강민규(서울과학기술대학교)

23SPP08-048 3D 프린팅으로 제작된 마이크로 구조를 활용한 다공성 압력센서 성능 향상 연구
강민규(서울과학기술대학교), 표순재(서울과학기술대학교), 최종안(서울과학기술대학교), 정진구(서울과학기술대학교)

23SPP08-049 전기분무 방법을 통한 실리콘-스테아르산이 코팅된 오일/수분 분리를 위한 초소수성 폴리스티렌 섬유질 막 제조
고성원(전북대학교), 김철생(전북대학교), 양홍석(전북대학교), 안동현(전북대학교), 박찬희(전북대학교)

23SPP08-050 MEMS 기반 혈관 압력 센서와 통합된 3D 프린팅 하이브리드 폴리머 스텐트
웨이진량(전남대학교), 이동원(전남대학교), 김동수(전남대학교), Nomin-Erdene Oyunbaatar(전남대학교)

23SPP08-051 심근세포의 전기 및 기계생리학적 분석을 위한 기능성 캔틸레버 기반의 약물 독성 스크리닝 플랫폼
푸자(전남대학교), 이동원(전남대학교), Nomin-Erdene Oyunbaatar(전남대학교), 김동수(전남대학교)

23SPP08-052 신체부착형 박막 웨어러블 압력 센서 제조
이종수(순천대학교), 김현리(순천대학교), 시바란지니 모하난(순천대학교)

23SPP08-053 롤투롤 인쇄 시스템 닥터 블레이딩 공정에서의 잉크 전이 거동에 대한 실험적 분석
이종수(순천대학교), 시바란지니 모하난(순천대학교), 김현리(순천대학교), 나게쉬판데이(순천대학교)

23SPP08-054 열경화성 고분자 나노섬유 개발을 위한 전기방사 공정 최적화
최은애(전북대학교), 김학용(전북대학교), 이정호(전북대학교), 오진(전북대학교), 이현지(전북대학교), 유건이(전북대학교), 이도희(전북대학교), 김준희(전북대학교)

23SPP08-055 열경화성 에폭시 나노섬유 직경 제어를 위한 전기방사 공정 인자 최적화
오진(전북대학교), 김학용(전북대학교), 이정호(전북대학교), 최은애(전북대학교), 이현지(전북대학교), 유건이(전북대학교), 김준희(전북대학교), 이도희(전북대학교)

23SPP08-056 전해 도금과 용액 공정을 통한 초소수성 필터 제작 기술 개발
강승민(충북대학교), 김건휘(충북대학교), 이동규(충북대학교), 김나경(충북대학교), 홍승미(충북대학교), 오동천(충북대학교)

23SPP08-057 ZnO 구조색 생성을 위한 저온 용액 공정 개발
이지홍(충북대학교), 김건휘(충북대학교), 음현일(충북대학교), 최문정(충북대학교), 김태균(충북대학교)

23SPP08-058 심근 조직 수축력 모니터링을 위한 크랙 기반 굽힘 센서 최적화
김정민(충남대학교), 조성진(충남대학교), 박찬(충남대학교), 이병준(충남대학교), 이하란(충남대학교), 박철정(충남대학교), 송치원(충남대학교), 강정범(충남대학교), 윤종원(충남대학교)

바이오헬스

23SPP09-001 웨어러블 보행보조로봇의 계단 보행 효율 검증: 예비 연구
장윤희(근로복지공단 재활공학연구소), 강정선(근로복지공단 재활공학연구소), 정보라(근로복지공단 재활공학연구소), 최병준(㈜위로보틱스), 임복만(㈜위로보틱스), 이연백(㈜위로보틱스)

심근세포의 전기 및 기계생리학적 분석을 위한 기능성 캔틸레버 기반의 약물 독성 스크리닝 플랫폼

Functional Cantilever-based Drug Toxicity Screening Platform for Electro-mechanophysiological Analysis of Cardiomyocytes

*푸자(전남대학교), Nomin-Erdene Oyunbaatar (전남대학교), 김동수(전남대학교), #이동원(전남대학교)
*P. P. Kanade, N.-E. Oyunbaatar, D.-S. Kim, #D.-W. Lee

Key words : Cardiomyocytes, Cantilever, Field potential, Contraction force, Strain sensor

During drug development, testing of the adverse effects of the potential drug candidates on the cardiac tissue is carried out at an early stage. This is necessary as drug-induced cardiotoxicity is a major factor of withdrawal of numerous drugs from the market. However, the current method of measuring electrophysiology using patch clamp technique has several limitations, as it can only measure ion channel currents and is an invasive technique. The cardiac cells also possess inotropic characteristics, the responses of which are necessary to assess during drug screening. Therefore, a platform that can measure both electrophysiological and contractile response of the cardiac tissue in a non-invasive manner is the need of the hour. Here, we propose a functional cantilever array-based drug screening platform that serves this purpose. Cardiomyocytes are cultured on the array of eight polymer cantilevers that displace with cardiac contraction force, and the strain sensor patterned on each cantilever can measure the contractility. On the other hand, microelectrodes are patterned on the cantilevers that measure the field potential of the cardiomyocytes. The platform was successfully tested using drugs like blebbistatin and quinidine. The proposed platform has the potential to be used for a complete assessment of cardiotoxicity.

후기 This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korean Government (MSIT) (No. 2020R1A5A8018367).

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Functional Cantilever-Based Drug Toxicity Screening Platform For Electro-Mechanophysiological Analysis Of Cardiomyocytes

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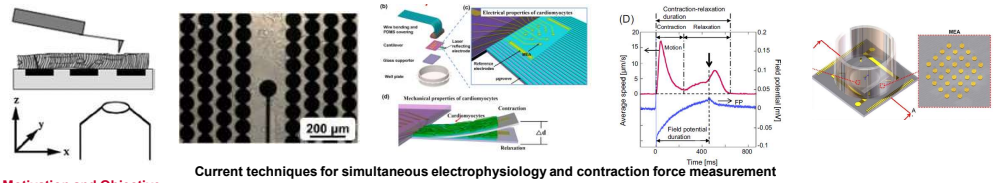
ABSTRACT

During drug development, testing of the adverse effects of the potential drug candidates on the cardiac tissue is carried out at an early stage. This is necessary as drug-induced cardiotoxicity is a major factor of withdrawal of numerous drugs from the market. However, the current method of measuring electrophysiology using patch clamp technique has several limitations, as it can only measure ion channel currents and is an invasive technique. The cardiac cells also possess inotropic characteristics, the responses of which are necessary to assess during drug screening. Therefore, a platform that can measure both electrophysiological and contractile response of the cardiac tissue in a non-invasive manner is the need of the hour. Here, we propose a functional cantilever array-based drug screening platform that serves this purpose. Cardiomyocytes are cultured on the array of eight polymer cantilevers that displace with cardiac contraction force, and the strain sensor patterned on each cantilever can measure the contractility. On the other hand, microelectrodes are patterned on the cantilevers that measure the field potential of the cardiomyocytes. The platform was successfully tested using drugs like blebbistatin and quinidine. The proposed platform has the potential to be used for a complete assessment of cardiotoxicity.

♦**Keywords : Cardiomyocytes, Cantilever, Field potential, Contraction Force, Strain Sensor, Microelectrode Array**

INTRODUCTION



Current techniques for simultaneous electrophysiology and contraction force measurement

Motivation and Objective

- Several drugs only show changes in contraction force but not electrophysiology of cardiac cells, and vice versa.
- Objective is to develop a high throughput integrated cardiac sensing drug screening platform for simultaneous measurement of electrophysiological and mechanical properties of cardiomyocytes

DEVICE CONCEPT

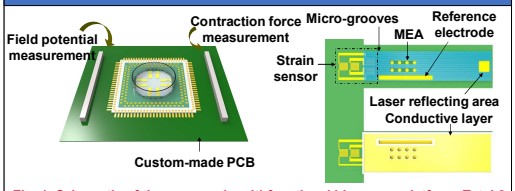


Fig. 1. Schematic of the proposed multi-functional biosensor platform. Total 8 cantilevers with MEA and strain sensors each. Diameter of MEA = 50 μm, pitch = 350 μm. Strain sensor is patterned in the half bridge configuration for the measurement of contractility.

DEVICE FABRICATION

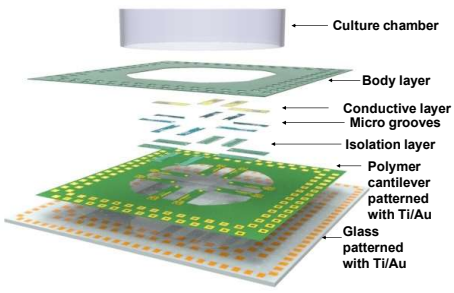


Fig. 2. Layer-wise breakup of the proposed dual-function biosensor. The cantilever-based device is made using SU-8 and bonded to glass using thermal bonding.

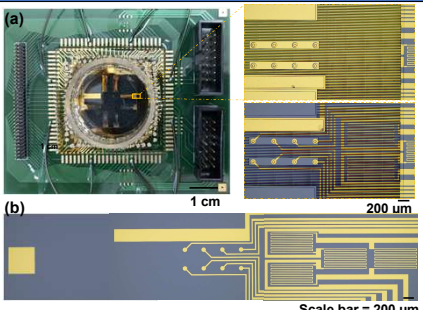


Fig. 3. (a) Photo of the fabricated device connected with PCB. Right side shows photo before and after conductive layer pattern. (b) Photo of cantilever before microgrooves pattern.

DEVICE CHARACTERIZATION

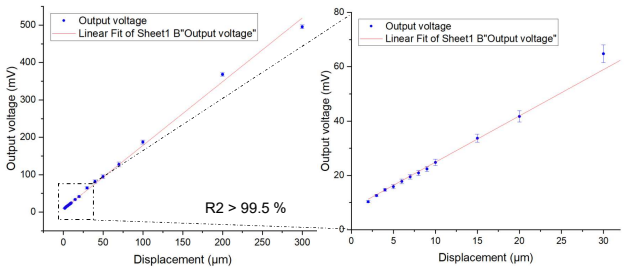
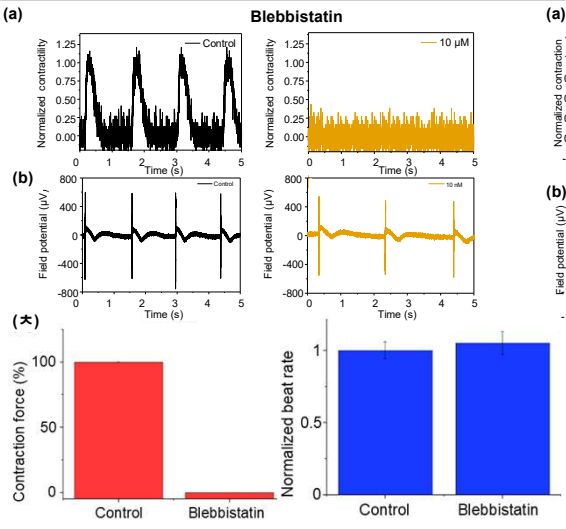


Fig. 4. (a) Characterization of the strain sensor to assess the minimum detectable displacement.

- The sensor output voltage shows high linearity with respect to the cantilever deflection.
- The minimum detectable displacement using strain sensor was 2 μm.

RESULTS



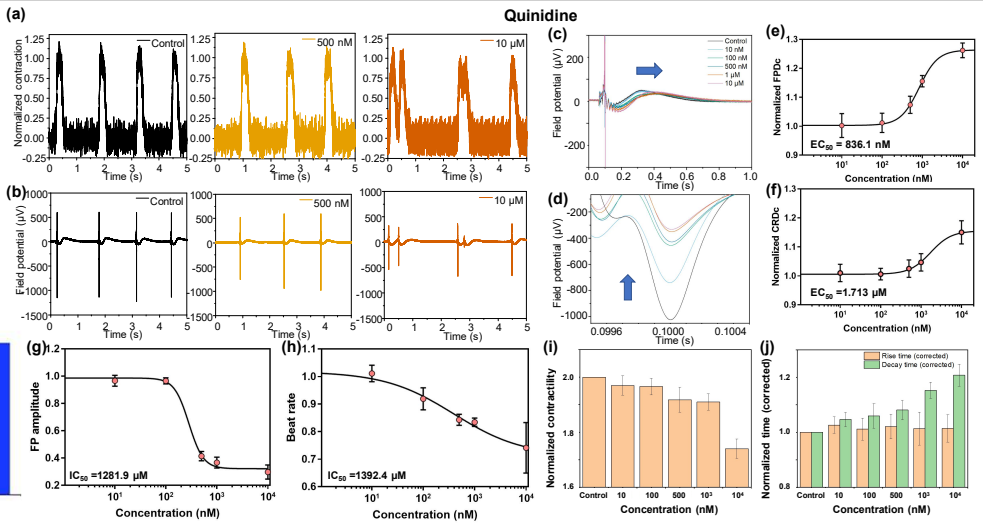


Fig. 5. Drug toxicity screening using Blebbistatin on the fabricated dual function platform. (a) Contraction force and ((b) field potential at control and on addition of 10 μM Blebbistatin. (c) Analysis of contraction force and beat rate.

Fig. 6. Drug toxicity screening using Quinidine on the fabricated dual function platform. (a) Contraction force and (b) field potential at control, 500 nM and 10 μM of the drug. (c) Increase in field potential duration (FPD) with the right-shift of the peak, (d) decrease in field potential spike amplitude, (e) change in FPD, (f) contraction-relaxation duration, (g) FP amplitude, (h) beat rate, (i) contractility and (j) rise time/decay time with concentration.

CONCLUSION

This work successfully demonstrated the simultaneous measurements of field potential and contraction force of the cardiac tissue using MEA and strain sensor. The platform could be fabricated using photolithography that can be upscaled for mass manufacturing. The strain sensor was sensitive enough to be able to detect displacement as low as 2 μm. The platform successfully measured field potential and contraction force generated by NRVM and was able to respond to drug toxicity using Blebbistatin and quinidine. Our novel platform has the potential to be used in pharmacological applications for the evaluation of drug induced toxicity.

ACKNOWLEDGMENT

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