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RAPID COMMUNICATION

Triboelectric nanogenerator for harvesting pendulum oscillation energy

Sangmin Lee[a,1], Yean Lee[b,1], Dongseob Kim[c], Ya Yang[a], Long Lin[a], Zong-Hong Lin[a], Woonbong Hwang[c], Zhong Lin Wang[a,d,*]

[a]*School of Material Science and Engineering, Georgia Institute of Technology, Atlanta, GA 30332-0245, USA*
[b]*Department of Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA 30332-0245, USA*
[c]*Department of Mechanical Engineering, Pohang University of Science and Technology, San 31, Hyoja, Namgu, Pohang, Gyungbuk 790-784, South Korea*
[d]*Satellite Research Facility, MANA, International Center for Materials Nanoarchitectonics, National Institute for Materials Science, 1-1 Namiki, Tsukuba 305-0044, Japan*

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KEYWORDS
Triboelectric nanogenerator;
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Abstract
There is abundance of lost mechanical energy that can be harvested and recycled from our living environment. Here we developed a pendulum motion based triboelectric nanogenerator (TENG) that sustains its motion with low maintenance providing multiple output peaks from a tiny-scale single mechanical triggering. The triboelectric effect of our device is enhanced by the surface structure of the PDMS that is composed of micro roughness with nanowires. We demonstrated lighting up a commercial LED light bulb by harvesting lost mechanical energy of the pendulum oscillation of a wall clock. Our approach can be a promising platform of developing a sustainable, low maintenance system to harvest lost mechanical energy.

Introduction

Harvesting wasted energy is likely a key solution for energy crisis and environmental health. There is abundance of ambient energy such as solar, thermal, wind, and mechanical energy in our daily life. Of the list, harvesting mechanical energy is most desired as it is not limited by the weather, day/night, season, temperature and/or location, as is the case for solar and wind energy. Recently, emerging nanotechnologies for harvesting mechanical energy using nanogenerators (NGs) have attracted a lot of attention for its potential to build cost-effective, self-powered system [1-9]. Several methods have been developed based on piezoelectric and triboelectric effects. Piezoelectric NG utilizes piezoelectric potential generated in nanowires (NWs) under dynamic strain. It can effectively convert mechanical energy into electrical current, harvesting energy from

*Corresponding author at: School of Material Science and Engineering, Georgia Institute of Technology, Atlanta, GA 30332-0245, USA.

E-mail addresses: sangmin.lee@mse.gatech.edu (S. Lee), zlwang@gatech.edu (Z.L. Wang).

[1]These authors contributed equally to this work.

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human motion, vibration and wind [10,11]. On the other hand, triboelectric nanogenerator (TENG) relies on the coupling of triboelectrification and electrostatic induction; when two materials with oppositely polarized triboelectric charges are subject to the periodic contact and separation either by press and release motion or planar sliding motion, the induced potential difference between the two electrodes can be changed cyclically, thus driving the alternating current flowing

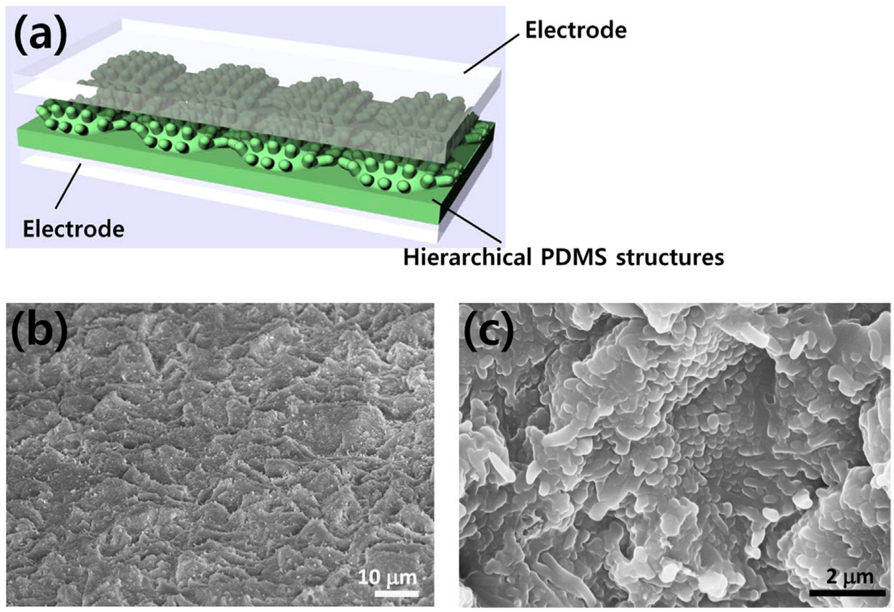

Figure 1 Schematics and SEM images of TENG with hierarchical PDMS structures. (a) Scheme of TENG with PDMS with micro-nano roughness on its surface. (b) SEM image of PDMS surface with micro structure and NWs. (c) Magnified SEM image of PDMS NWs on micro structures.

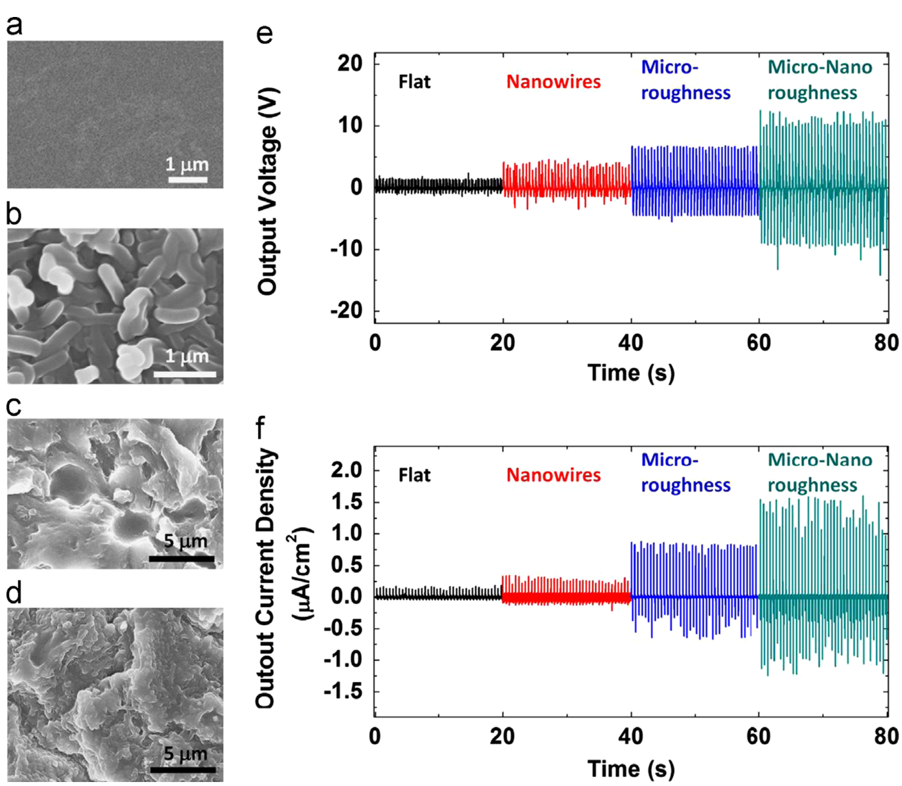

Figure 2 Comparison of TENG performance respect to different surface roughness. SEM image of (a) flat, unaltered surface of PDMS, (b) PDMS surface containing only NWs, (c) PDMS surface with micro structure only, and (d) PDMS surface with both micro structures and NWs. Experimental results of (e) output voltage and (f) current density with different surface roughness measured under the same experimental conditions.