Effect of surface modification on charge generation in a Triboelectric Nanogenerator

M. A. Parvez Mahmud, Jaejong Lee, Geehong Kim, Hyungjun Lim, Kee-Bong Choi

* University of Science and Technology, Daejeon, 305-350, South Korea
* Korea Institute of Machinery and Materials, Daejeon, 305-343, South Korea
e-mail: kbchoi@kimm.re.kr

Keywords: Triboelectric Nanogenerator, surface modification, pillar pattern, charge generation.

Abstract:

The development of smart systems for collecting mechanical energy from a working environment and converting it into electricity has attracted increasing interest not only for meeting rapidly-growing energy needs but also for achieving self-powered systems, and to energize the portable electronics used in our everyday life [1]. For these reasons, researchers have developed various approaches based on photovoltaics, electromagnetics, electrostatics, piezoelectrics, pyroelectrics, and so on. Recently, the triboelectric nanogenerator (TENG) has emerged as an effective energy harvesting technology to utilize random mechanical energy for powering nano devices employing triboelectrification and electrostatic induction [2]. However, the power generation in TENG is usually limited due to the natural phenomenon of triboelectric effects. The enhancement of power, which is crucial for high powered TENG fabrication, is possible by decreasing the effective distance (d) between contacting materials and also by increasing the surface charge density (σ) on touching areas through surface modifications [3, 4].

In this study, the power production in TENG was augmented by formulating pillar patterns with different diameter on polydimethylsiloxane (PDMS) and polymethyl methacrylate (PMMA) surfaces. The voltage and current caused by electrostatic charges resulting from repeated touch between triboelectric objects was analyzed, and investigated. An automated up-down movement system was used to make periodic contact between PDMS and PMMA layers. In order to investigate the effect of nanostructures, pillar shaped nano pattern arrays with four different diameters (200 nm, 250 nm, 300 nm and 350 nm) the same height (250 nm) and the same pitch (p=1,500 nm and p=900 nm) were fabricated using thermal nanoimprint lithography on the contacting portion of both triboelectric materials. Experiments demonstrated that the pillar shaped nano patterns with smaller diameter generate higher output voltage, current and power compared to those with larger diameter. Consequently, it was determined that the power output of 200 nm pillar patterned TENG was almost 6 times higher compared to unstructured films. Moreover, it was revealed that the maximum output current and voltage of TENG having 200 nm pillar morphologies on the contacting areas were almost four times and 1.5 times greater than that of TENG without any patterns, respectively. These results will be helpful for fabricating a self-powered nano system with high efficiency and low cost.

References: