Author's Accepted Manuscript

www.elsevier.com/locate/jmbbm

Effect of compliant layers within piezoelectric composites on power generation providing electrical stimulation in low frequency applications

E.D. Krech, E.S. Cadel, R.M. Barrett, E.A. Friis

PII: S1751-6161(18)30989-5
DOI: https://doi.org/10.1016/j.jmbbm.2018.08.027
Reference: JMBBM2938

To appear in: *Journal of the Mechanical Behavior of Biomedical Materials*

Received date: 3 July 2018
Revised date: 10 August 2018
Accepted date: 19 August 2018

Cite this article as: E.D. Krech, E.S. Cadel, R.M. Barrett and E.A. Friis, Effect of compliant layers within piezoelectric composites on power generation providing electrical stimulation in low frequency applications, *Journal of the Mechanical Behavior of Biomedical Materials,* https://doi.org/10.1016/j.jmbbm.2018.08.027

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting galley proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

Effect of compliant layers within piezoelectric composites on power generation providing electrical stimulation in low frequency applications

E. D. Krech[1], E. S. Cadel[1], R. M. Barrett[2], E. A. Friis[1,3]

[1]University of Kansas, Bioengineering Graduate Program, Lawrence, KS, USA;

[2]University of Kansas, Department of Aerospace Engineering, Lawrence, KS USA;

[3]University of Kansas, Department of Mechanical Engineering, Lawrence, KS, USA

Corresponding Author:

Elizabeth A. Friis
Professor, Mechanical Engineering
University of Kansas
1530 W. 15th St., 3138 Learned Hall
Lawrence, KS 66045
lfriis@ku.edu
785-550-3725
785-864-5254 (fax)

Declarations of interest: none

Abstract:

For patients that use tobacco or have diabetes, bone healing after orthopedic procedures is challenging. Direct current electrical stimulation has shown success clinically to significantly improve bone healing in these difficult-to-fuse populations. Energy harvesting with piezoelectric material has gained popularity in the last decade, but is challenging at low frequencies due to material properties that limit total power generation at these frequencies. Stacked generators have been used to increase power generation at lower voltage levels but have not been widely explored as a load-bearing biomaterial to provide DC stimulation. To match structural compliance levels and increase efficiency of power generation at low frequencies, the effect of compliant layers between piezoelectric discs was investigated. Compliant Layer Adaptive Composite Stacks (CLACS) were manufactured using five PZT discs connected electrically in parallel and stacked mechanically in series with a layer of low modulus epoxy between each disc. The stacks were encapsulated, keeping PZT and overall volume constant. Each stack was electromechanically tested by varying load, frequency, and resistance. As compliant layer thickness increased, power generation increased significantly across all loads, frequencies, and resistances measured. As expected, increase in frequency significantly increased power output for all groups. Similarly, an increase applied peak-to-peak mechanical load also significantly increased power output. The novel use of CLACS for power generation under load and frequencies experienced by typical orthopedic implants could provide an effective method to harvest energy and provide power without the use of a battery in multiple low frequency applications.

Accepted manuscript

Download English Version:

https://daneshyari.com/en/article/9952829

Download Persian Version:

https://daneshyari.com/article/9952829

Daneshyari.com