

Invited Papers

Plantar Pressure Measurement Using Sol–Gel Composite Piezoelectric Film Sensors for Prosthetic and Orthotic Fabrication

H. Odagawa^{1*}, M. Kobayashi², K. Tokuda³

¹National Institute of Technology, Kumamoto College, 2659-2 Suya, Koshi 862-0909, Japan

²Kumamoto University, 2-39-1 Kurokami, Chuo-ku, Kumamoto 860-8555, Japan

³TOKUDA Prosthetics and Orthotics Mfg Ltd., 6-27-20 Oue, Chuo-ku, Kumamoto 862-0971, Japan

***Email:** odagawa@kumamoto-nct.ac.jp

Abstract: In the field of prosthetics and orthotics, pressure measurement is performed to evaluate the physical condition of users and to verify the effectiveness of fabricated devices. In particular, in order to prevent discomfort or pain at the interface between the body and the device, it is necessary to adjust the distribution of applied forces according to individual users. Therefore, there is a strong demand for pressure measurement devices that enable simple and practical evaluation.

The pressure sensor is required to be thin and flexible to conform to the curved surfaces of the body and the device. In addition, even if the force distribution is appropriate in a static condition, it can change during motion, creating a need to measure pressure variations during movement. To solve these requirements, we consider piezoelectric sensors based on sol–gel composite films to be an effective solution.

Sol–gel composite piezoelectric thin films are fabricated by dispersing piezoelectric ceramic powder in a sol–gel solution and coating and firing it onto a metal substrate. The films fabricated by spray coating [1] exhibit a porous microstructure, which provides high flexibility. When the film is deposited on thin metal foil substrates, the sensors can be bent, which is a notable characteristic.

In this study, a sensor with a thickness of approximately 0.2 mm fabricated using a sol–gel composite was inserted between an in-shoe insole and the foot, and pressure variations during walking were measured. In general, piezoelectric materials generate a voltage at the moment when strain occurs (i.e., when force is applied); however, because the generated charge is neutralized by externally connected measurement equipment, the voltage rapidly decays. As a result, forces that change slowly over time cannot be measured accurately. To address this issue, we investigated methods based on integrating the output voltage and on solving an inverse problem using frequency response of the sensor. As a result, we obtained measurement results that reasonably represent the variation of forces acting on the plantar surface during walking, indicating that this sensor has strong potential for application in the field of prosthetic and orthotic fabrication.

Keywords: Prosthetics and Orthotics, pressure measurement, Sol-gel composite piezoelectric film

References

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