J Electroceram (2014) 32:383–389
DOI 10.1007/s10832-014-9928-y

Fabrication and characterization of piezoelectric driven microdiaphragm resonating sensor for a biosensing application

Myung-Sic Chae · Sang-Myung Lee · Yong Kyoung Yoo · Soo Hyun Lee · Jinsik Kim · Tae Song Kim · Dong June Ahn · Jeong Hoon Lee · Kyo Seon Hwang

Received: 6 March 2014 / Accepted: 9 May 2014 / Published online: 31 May 2014

Abstract The detection capability of microresonating sensors is decided by the resonant properties (mass sensitivity and quality factor) because the microresonating sensors have detection principle that the target material of small amount quantitatively detect by measuring the resonant properties change of microresonators. Mass sensitivity is important factor to evaluate minimum detectable mass of microresonating sensors. For the biomolecule detection in liquid, microresonaotrs have to keep the quality factor that can discriminate small frequency change when the liquid sample injected on the microresonating sensors. In order to study mass sensitivity and quality factor of the fabricated microdiaphragm sensors, Pt thin film with different thicknesses are deposited on the our $Pb(Zr_{0.52}Ti_{0.48})O_3$ layer-embedded microdiaphragm sensors. Increasing the mass sensitivity ranging from 1.68 to 36.61 Hz/ng which is found with the decreasing the width of squared microdiaphragms ranging 900 to 300 μm. The mass sensitivity of our microdiaphragm sensor stands comparison with microcantilever sensor of length scale of 200~300 μm. Moreover, we find that the quality factor is kept on more than 23 that was ten times better than microcantilever resonating sensor with length scale of 200 μm.

Keywords Diaphragm sensor · membrane resonator · quality factor · resonant frequency · mass sensitivity

Myung-Sic Chae and Sang-Myung Lee contributed equally to this work.

M.-S. Chae · Y. K. Yoo · S. H. Lee · J. Kim · T. S. Kim · K. S. Hwang (✉)
Center for BioMicrosystems, Korea Institute of Science and Technology (KIST), Seoul 136-791, Republic of Korea
e-mail: kshwang@kist.re.kr

M.-S. Chae · D. J. Ahn
College of Engineering, Korea University, Seoul 136-701, Republic of Korea

S.-M. Lee
Department of Chemical Engineering, Kangwon National University, Kangwon-do 200-701, Republic of Korea

Y. K. Yoo · J. H. Lee (✉)
Department of Electrical Engineering, Kwangwoon University, Seoul 139-701, Republic of Korea
e-mail: jhlee@kw.ac.kr

1 Introduction

Over the past few decades, there have been growing efforts to develop versatile sensor platforms with excellent sensing performance that are capable of detecting the specific biomolecules in liquid samples [1–3]. In terms of new disease diagnosis paradigm that moving diagnosis from bench to bedside, highly sensitive biomolecule detection system based on the portable biosensor has been spotlighted. Micro/nano-electro-mechanical system (MEMS/NEMS) technology provides new opportunities for the development of portable biosensors with improved [4–7]. Advances in micro/nano-fabrication technologies allow sensor development operated in range of micro/nano-meter.

In general, microresonating sensors based on the MEMS/NEMS technology have been widely used as gravimetric analysis tool for the detection of biological elements such as disease-related protein, DNA with specific sequences, and various other biocompounds [8, 9]. Microresonators are able to quantitatively detect the specific targets in liquid matrices by monitoring the resonant frequency variance of recognition elements formed resonators. When the specific targets bind to the recognition elements of a microresonating sensor, the resonant frequency of the microresonating sensor is decreased in the lower frequency range caused by mass loading because the resonant frequency of microresonators is inversely proportional to the square root of the resonator mass