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Nano-G metrology system and its biomedical applications by CMOS-MEMS technology

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MEMS (Micro-electromechanical systems) technology has enabled micro-scaled capacitive accelerometers to be widely available in consumer electronics for the sensing range to be mostly above 1G (9.8 m/s^2). In recent years, accurate sensing of low acceleration, specifically below 1G (9.8 m/s^2), has been one of the major interests for MEMS accelerometers to be used for applications such as human-activities monitoring or the integrated inertial measurement unit. The commercialized MEMS accelerometers exhibit, however, insufficient performance for sub-1G sensing due to the mechanical noise that determines the sensitivity of the sensor. The mechanical noise is dominated by Brownian noise (B_N), and B_N is inversely proportional to the proof mass where silicon is used as the material in most MEMS accelerometers; the physical dimension of the silicon proof mass constrains the minimum level of B_N, which is typically in the range from 100 to 1000 μG/Hz$^{1/2}$. For the reduction of the BN on micro-scale accelerometers, we have employed gold as a material of the proof mass. Owing to the high density of gold, the BN can easily be an order of magnitude smaller than that of silicon proof mass. Moreover, the MEMS sensor can be made by a post-CMOS (complementary metal-oxide semiconductor) process using gold electroplating. The post-CMOS process can also help to shrink the device footprint by implementing the MEMS structures onto the sensing CMOS circuitry. By utilizing the above approaches, the developed MEMS capacitive sensor showed the BN to be less than 1 μG/Hz$^{1/2}$. The proposed MEMS accelerometers can be of great use to a wide variety of technologies that need to sense micro-motion, and highly-sensitive monitoring of body movements will shed light on the medical and healthcare application.

Biography

Daisuke Yamane received the BS, MS and PhD degrees in Electrical and Electronic Engineering from The University of Tokyo, Tokyo, Japan, in 2006, 2008, and 2011, respectively. From 2010 to 2012, he was a Research Fellow of the Japan Society for the Promotion of Science hosted within the Research Center for Advanced Science and Technology, The University of Tokyo. From 2011 to 2012, he was a Visiting Scholar at the University of California, Los Angeles, CA, USA. Since 2012, he has been an Assistant Professor with Precision and Intelligence Laboratory, Tokyo Institute of Technology, Kanagawa, Japan. His research interests include radio-frequency (RF) microelectromechanical systems (MEMS), MEMS inertial sensors, and (complementary metal-oxide semiconductor) CMOS-MEMS technology.

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