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Piezoelectric Biomedical microelectromechanical systems (BioMEMS) for implantable energy harvesting (EH) applications

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Nowadays it is in constant growing the interests of piezoelectric energy harvesting (EH) power microelectromechanical systems (MEMS). If the piezoelectric material is going to be implanted in the human body, an important requirement is the biocompatibility of the implant. In this regard, Aluminum Nitride (AlN) has emerged as an attractive alternative for use in biomedical MEMS (BioMEMS). It is also becoming important to be able to integrate piezoelectric films with materials used in medical devices. Ultrananocrystalline diamond (UNCD) in thin film form, is a multifunctional material, which is extremely bioinert and biocompatible. Since both UNCD and AlN films can be processed via photolithography processes used in MEMS, the integration of UNCD and AlN films provides the bases for developing a new generation of biocompatible BioMEMS. Research and development was conducted to produce implantable MEMS based EH devices: Pt/piezoelectric AlN/Pt layer heterostructure was grown and patterned on the UNCD membrane with a Ti adhesion layer. By applying voltages between the top and bottom Pt electrodes layers the piezoelectric AlN layer is energized. A direct method for the deposition of AlN on Pt/Ti/UNCD/SiO2/Si substrate avoiding polishing steps and thus reducing fabrication times has been shown; also, the integration of AlN and UNCD has shown a high piezoelectric coefficient. The feasibility of the fabrication of biocompatible AlN/UNCD based thin film bulk acoustic resonator (FBAR) structure for EH implantable applications has been demonstrated. It is the opinion of the author that a huge field for implantable energy harvesting applications based on AlN/UNCD is awaiting to be explored.

Keywords: BioMEMS, Energy Harvesting, Aluminum Nitride, Ultrananocrystalline diamond.