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Piezoelectric Soft MEMS for Energy Harvesting

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Portable electronics is being increasingly pervasive and ubiquitous in our lives and activities. Batteries, primary energy source for small electronic devices, are becoming smaller and more efficient but still show high restrictions: toxicity, limited life-time, cyclic replacing/recharging operations. To overcome these issues a stand-alone compact electronic system should have an ancillary device that collects energy from the environment for battery recharging. To this aim emerging MEMS technologies based on piezoelectric materials exploit kinetic energy, such as ambient vibrations or air flows, and provide μW-order power generators. In this work, flexible piezoelectric multilayered structures based on Aluminum Nitride (AlN) has been optimized on a polymeric soft substrate of Kapton foil in order to design and fabricate a prototype of flexible harvester. This device exploits the properties of the AlN, such as its biocompatibility (being lead-free), good piezoelectric coefficient, low dielectric constant and easy deposition process. The flag-shape guarantees an efficient energy conversion and the device can act as energy harvesters from wind at extremely low speeds. While extremely flexible, the Mo/AlN/Mo structure, grown by sputtering deposition, has been optimized to result crack-free even after the micro-fabrication procedure, peeling off from its rigid support and several cycles of bending, withstanding to high stresses and large deformations of the substrate. Indeed, the thin films structure allows to distribute the stress produced during the flapping of the flag through the grains boundaries of the films, preventing the propagation of dislocations and defects. Piezoelectric mini-flags have been fabricated by standard micro fabrication processes and the devices have been tested using a wind tunnel setup, demonstrating a very low cut-in speed, of 0.4 m/s with a maximum generated voltage of 0.6 V and an average volume power density of 0.257 mW/cm^3 at a wind speed of 9 m/s.

Keywords: Flexible; Piezoelectric; Aluminum Nitride; Harvesting, Sensor