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Design and Fabrication of Piezoelectric Tactile Sensor by Deposition of PVDF-TrFE with Spin-Coating Method for Minimally Invasive Surgery

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Abstract : Since last two decades, minimally invasive surgery (MIS) has grown significantly due to its advantages compared to the traditional open surgery like less physical pain, faster recovery time and better healing condition around incision regions; however, one of the important challenges in MIS is getting an effective sensing feedback within the patient's body during operations. Therefore, surgeons need efficient tactile sensing like determining the hardness of contact tissue for investigating the patient's health condition. In such a case, MIS tactile sensors are preferred to be able to provide force/pressure sensing, force position, lump detection, and softness sensing. Among different pressure sensor technologies, the piezoelectric operating principle is the fittest for MIS's instruments, such as catheters. Using PVDF with its copolymer, TrFE, as a piezoelectric material, is a common method of design and fabrication of a tactile sensor due to its ease of implantation and biocompatibility. In this research, PVDF-TrFE polymer is deposited via spin-coating method and treated with various post-deposition processes to investigate its piezoelectricity and amount of electroactive β phase. These processes include different post thermal annealing, the effect of spin-coating speed, different layer of deposition, and the presence of additional hydrate salt. According to FTIR spectroscopy and SEM images, the amount of the β phase and porosity of each sample is determined. In addition, the optimum experimental study is established by considering every aspect of the fabrication process. This study clearly shows the effective way of deposition and fabrication of a tactile PVDF-TrFE based sensor and an enhancement methodology to have a higher β phase and piezoelectric constant in order to have a better sense of touch at the end effector of biomedical devices.

Keywords : β phase, minimally invasive surgery, piezoelectricity, PVDF-TrFE, tactile sensor
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