Novel Piezoelectric Nanogenerator for Biomedical Applications

Joshi, Annika (School: Johns Creek High School)

Every year, millions of people incur damage to sensory receptors that interact with the external environment. Two areas of concern are hearing loss (affecting around 700 million by 2050) and burns (affecting 11 million annually). Current treatments for burns involve skin grafts, which are expensive and prone to rejection by the body. Current treatments for hearing loss involve implants and hearing aids, which have limited sensitivity, need batteries and charging, and are expensive, large, and prone to infection. Thus, there is a need for a self-powered, flexible, biocompatible, antibacterial, and inexpensive solution that can respond to stimuli at a rate comparable to tissue. Piezoelectric materials convert mechanical energy into electricity, replicating touch and hearing by simulating nerve signals. In this study, membranes with varying ratios of polyvinylidene fluoride (PVDF) and zinc oxide (ZnO) were fabricated using electrospinning. These membranes were characterized with scanning electron microscopy (SEM), x-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), stress-strain analysis, and piezoresponse testing. Results showed that increasing the amount of PVDF made the membrane more flexible but reduced its piezoelectric potential (decrease in PVDF beta-phase). Increasing the amount of ZnO significantly increased piezoelectric potential (increase in PVDF beta-phase) but degraded the flexibility and usability of the membrane. Therefore, a 1:1 w/w ratio of PVDF to ZnO is the optimum ratio for balancing both piezoelectric potential and flexibility. These results support the hypothesis that composites of PVDF and ZnO can help realize self-powered hearing rehab devices and wearable electronic skin.

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