Polyvinylidene fluoride or polyvinylidene difluoride is a highly non-reactive thermoplastic fluoropolymer produced by the polymerization of vinylidene difluoride. PVDF is a specialty plastic used in applications requiring the highest purity, as well as resistance to solvents, acids and hydrocarbons.

A polyvinylidene fluoride (PVDF) piezoelectric membrane containing carbon nanotubes (CNTs) and graphene oxide (GO) additives was prepared, with special emphasis on the piezoelectric activity of the aligned fibers. Fibroblast viability on membranes was measured to study cytotoxicity. Osteoprogenitor D1 cells were cultured, and mineralization of piezoelectric composite membranes was assessed by ultrasound stimulation. Results showed that the electrospun microstructures were anisotropically aligned fibers. As the GO content increased to 1.0 wt% (0.2 wt% interval), the β phase in PVDF slightly increased but showed the opposite trend with the increase in CNT. Excessive addition of GO and CNT hindered the growth of the β phase in PVDF. The direct piezoelectric activity and mechanical properties showed the same trend as the β phase in PVDF. Moreover, GO/PVDF with the same nanoparticle content showed better performance than CNT/PVDF composites. In this study, a comparison of the generated piezoelectric specific voltage (unit: 10-3 Vg-1 cm-2, linear stretch, g33) with control PVDF only (0.55 ± 0.16) revealed that the two composites containing 0.8 wt% GO- and 0.2 wt% CNT- with 15 wt% PVDF exhibited excellent piezoelectric voltages, which were 3.37 ± 1.05 and 1.45 ± 0.07 (10-3 Vg-1 cm-2), respectively. In vitro cultures of these two groups in contact with D1 cells showed significantly higher alkaline phosphatase secretion than the PVDF only group within 1-10 days of cell culture. Further application of ultrasound stimulation showed that the piezoelectric membrane differentiated D1 cells earlier than without ultrasound and induced higher proliferation and mineralization. This developing piezoelectric effect is expected to generate voltage through activities to enhance microcurrent stimulation in vivo [1)]

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Chen WC, Huang BY, Huang SM, Liu SM, Chang KC, Ko CL, Lin CL. In vitro evaluation of electrospun polyvinylidene fluoride hybrid nanoparticles as direct piezoelectric membranes for guided bone regeneration. Biomater Adv. 2022 Nov 30;144:213228. doi: 10.1016/j.bioadv.2022.213228. Epub ahead of print. PMID: 36481520.