A biodegradable PVDF-based piezoelectric nanogenerator with DNA assisted β-phase nucleation and molecular dipole ordering

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Energy harvesting from alternate sources with flexible piezoelectric-based nanogenerators is becoming a growing trend to provide power in portable electronic devices. In addition, biomedical implants require such self-sustaining devices which are compatible and biodegradable.

In this work, a flexible nanogenerator (NG) is realized with poly(vinylidene fluoride) (PVDF) film, where deoxyribonucleic acid (DNA) is selected as agent for the electroactive β-phase nucleation. The denatured DNA molecule with available H-bonds and surface negative charges co-operates in aligning the CH$_2$/CF$_2$ dipoles of PVDF which are mainly responsible for the piezoelectric behavior of this polymer. It is especially noteworthy that the additional electrical poling step for the β-phase nucleation is not necessary.

We have found, that the flexible NG prepared with the DNA-PVDF exhibits energy harvesting from external mechanical motions such as repeated finger impacting, footsteps, and object drops (e.g. football). The electrical energy generated by the NG is capable to charge capacitors and light up several LEDs providing a wide scope for the design of self-powered portable piezoelectric devices in the near future. As DNA is the nucleating agent for the electroactive phase, the lack of toxic heavy metals and compounds render the NG completely biodegradable and compatible making it ideal for biomedical implants and sensors. [1]