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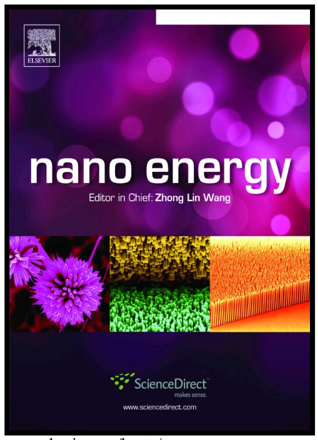

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Piezoelectric diphenylalanine peptide for greatly improved flexible nanogenerators

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Abstract

We explored the piezoelectric behavior of diphenylalanine (FF)[1] peptide using multiphysics finite element models. We compared the piezoelectric potential developed in a finite element model of an FF peptide nanowire with the potential developed in conventional piezoelectric materials. The simulation showed that the FF peptide nanowire can generate significantly higher voltage than nanowires made from piezoelectric materials such as zinc oxide, lead zirconate titanate, and barium titanate under the same force. The simulation work was expanded to create a complete model of a flexible nanogenerator based on FF peptide microrods. Based on the piezoelectric potentials calculated in the nanogenerator model, we estimated an open circuit voltage for the FF nanogenerator. To validate the model, we fabricated and demonstrated the first flexible piezoelectric nanogenerator based on vertical arrays of FF peptide microrods. We characterized the electrical behavior of the fabricated nanogenerators, and measured an open circuit voltage of up to -0.6 V. The estimated open circuit voltage predicted by the model was in close agreement with the measured value from the fabricated nanogenerator. The results illustrate the promising potential of FF peptide as a piezoelectric material, and show the importance of finite element models for providing insight into the development of a new generation of FF peptide-enabled devices.