Flexible Piezoelectric Energy Harvester with Ultrahigh Transduction Coefficient by Interconnected Skeleton Design Strategy

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Explanation for the finite element analysis

The finite element analysis was conducted to provide theoretical evidence on the mechanism of the enhanced piezoelectric effect in the 2-2 type PZN-PZT/PDMS with interconnected porous structure. For comparison, the analysis of 0-3 type PZN-PZT/PDMS with randomly-distributed particle was also performed.

Under the same external force conditions, the ice-templated 2-2 type composite shows higher applied net stress on the PZN–PZT element than the case of the 0-3 type counterpart. This larger induced stress would generate a stronger piezoelectric polarization, and as a result, stronger piezoelectric voltage response. The total piezoelectric field response in the 2-2 type composite is clearly higher than that of the 0-3 type composite, which agrees qualitatively with our experimental energy harvesting signals.

Ceramic material is set as PZT-5H in the material library in Comsol Multiphysics. The radius of ceramic particle is set to 2 μm. The boundary load is set to 0.08 MPa, which is similar to our experiments. The thickness of the composite material is set to 46 μm.

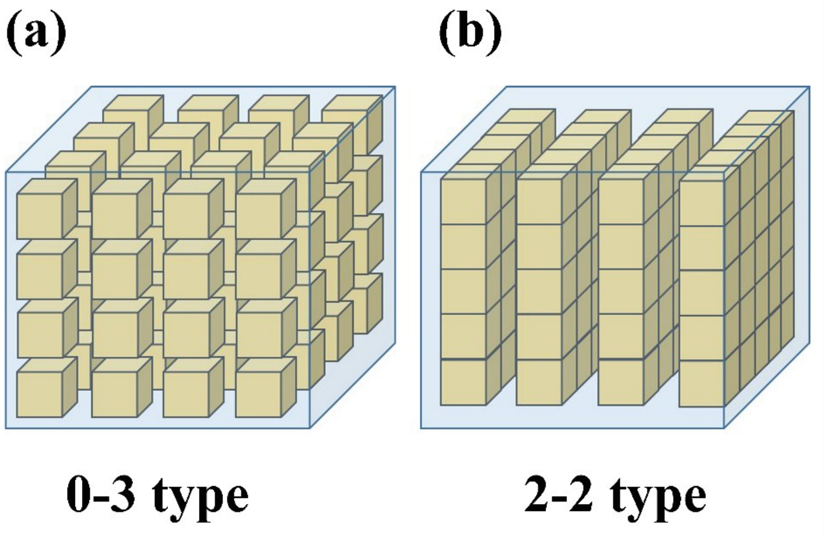

Figure S1. Two connective patterns for a two-phase system. The orange cube represents ferroelectric ceramic particle and the part of pale blue represents the polymer: (a) 0-3 type ceramic/polymer composite. (b) 2-2 type ceramic/polymer composite.

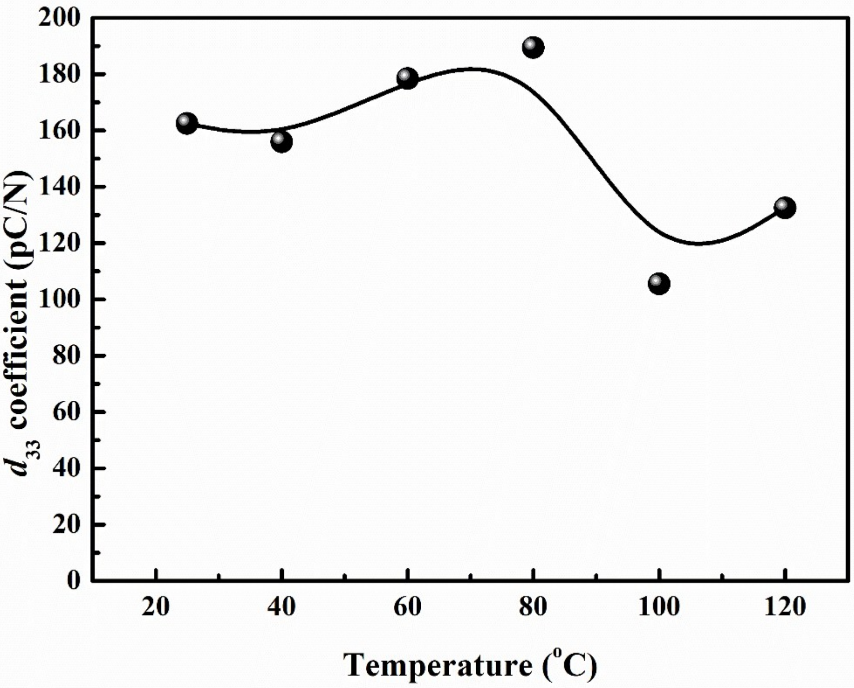

Figure S2. Poling temperature dependence of the d_{33} of PZN-PZT/PDMS

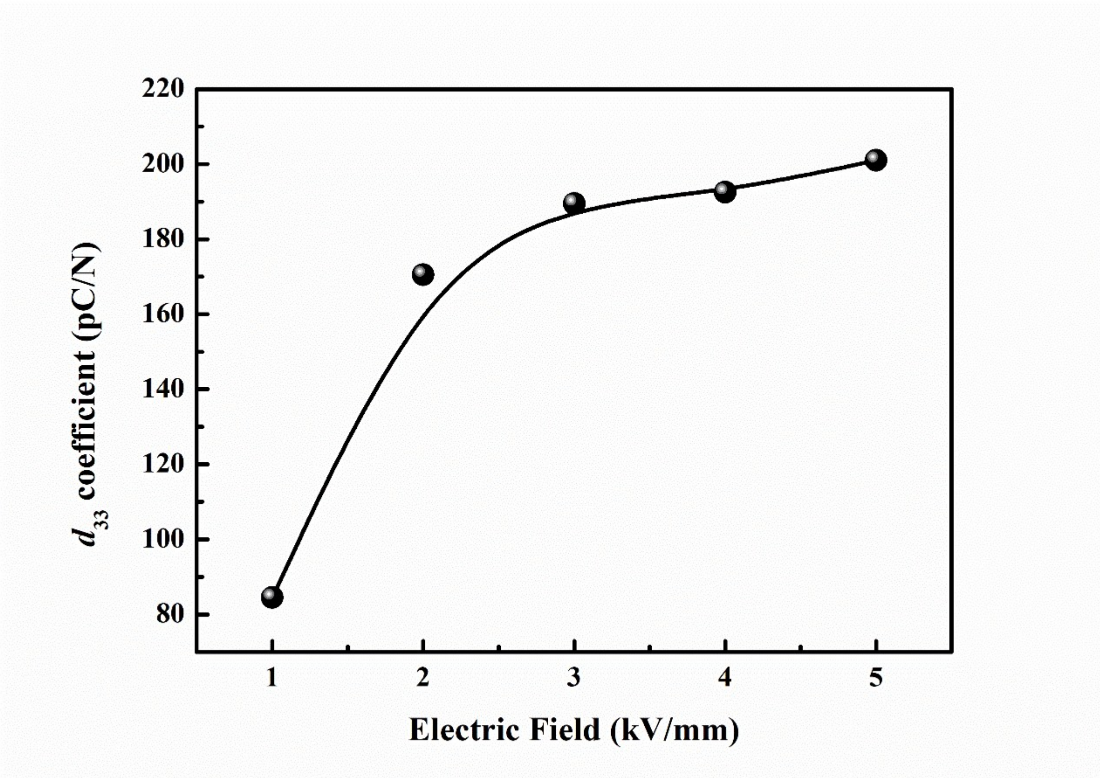

Figure S3. Poling electric field dependence of the d_{33} of PZN-PZT/PDMS with fixed temperature 80 ^{o}C

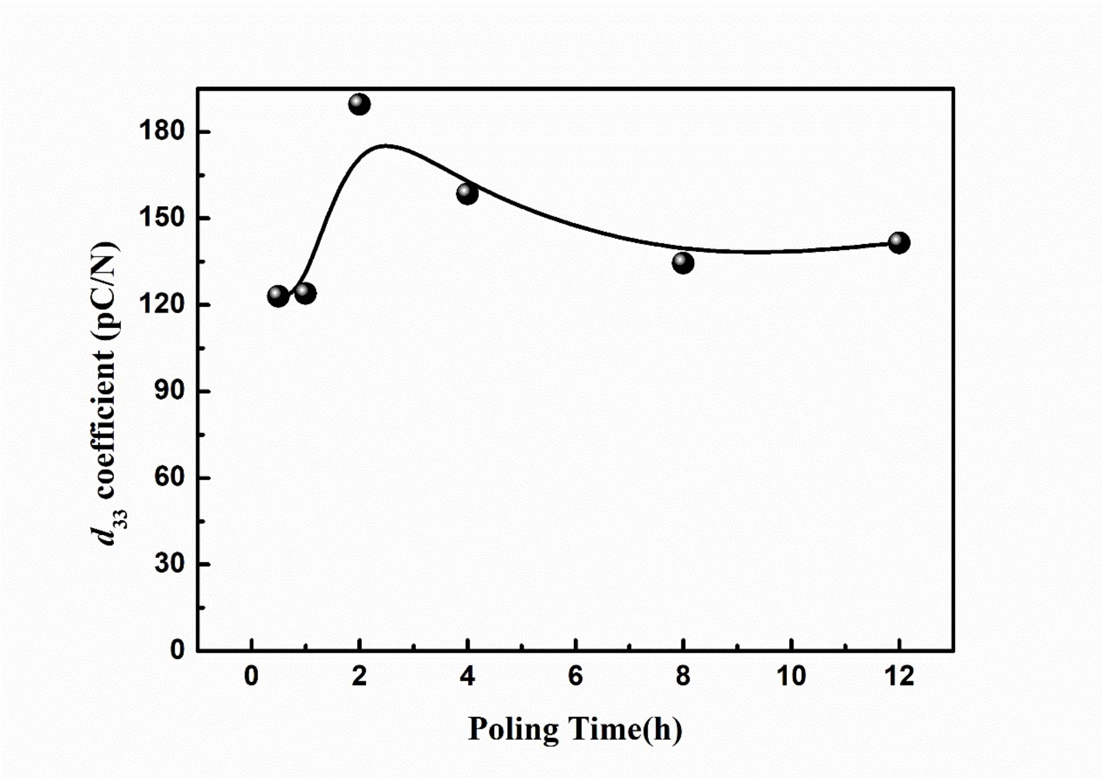

Figure S4. Poling time dependence of the d_{33} of PZN-PZT/PDMS with fixed electric field 30 kV/cm and 80 ^{o}C

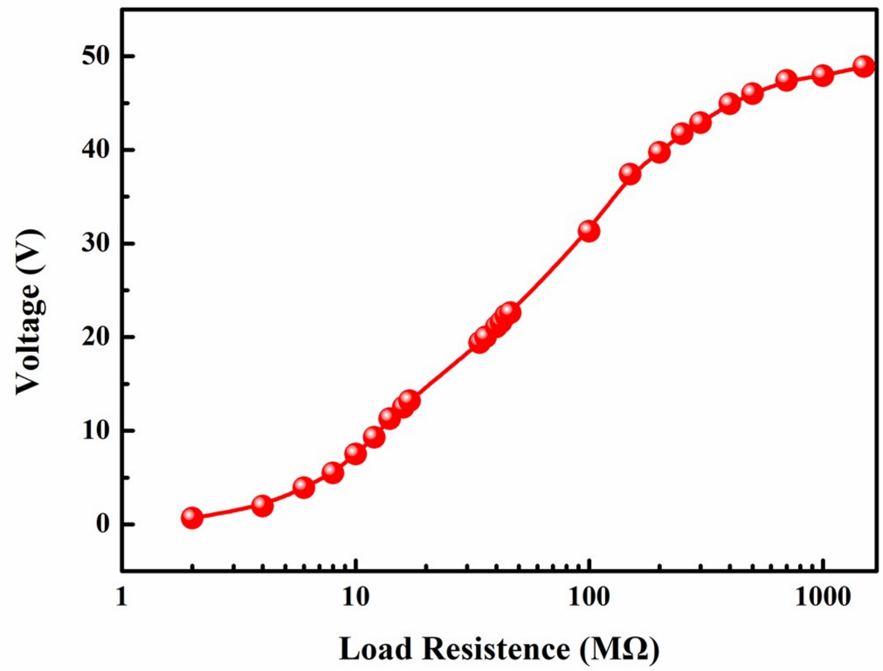

Figure S5. Correlation between the generated voltage and the load resistance.

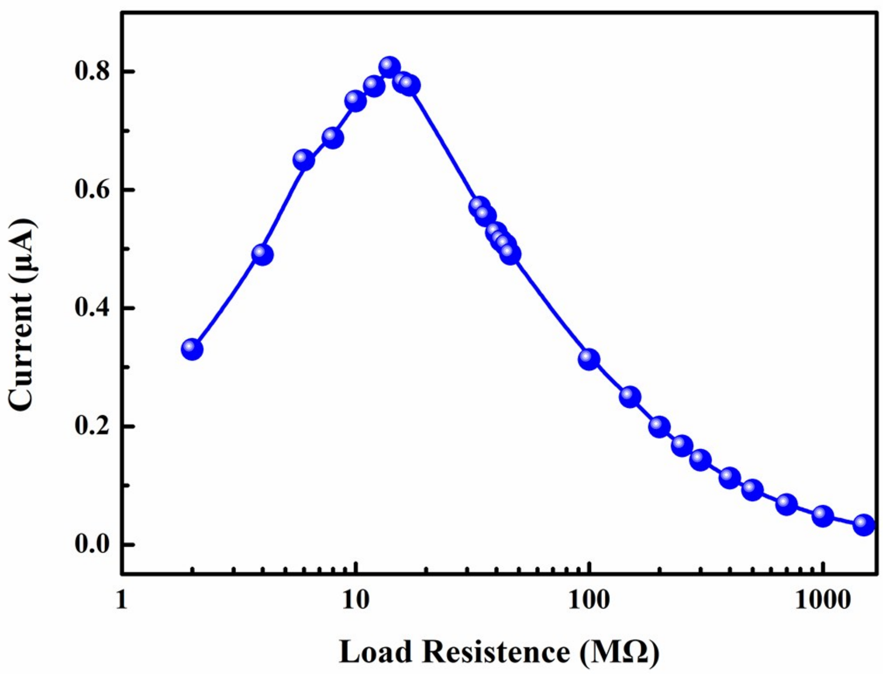

Figure S6. Correlation between the generated current and the load resistance.