Erratum: Dramatic enhancement in energy harvesting for a narrow range of dimensions in piezoelectric nanostructures [Phys. Rev. B 78, 121407(R) (2008)]

M. S. Majdoub, P. Sharma, and T. Çağin

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In a recent erratum,[1] we fixed an error found in the constitutive Eqs. (19) and (20) in Ref. 2. As a consequence, we proceed to give the revised expressions for Eqs. (9) and (10) in Ref. 3. The fundamental conclusions of our work (e.g., dramatic enhancement in energy harvesting for a narrow range of dimensions in piezoelectric nanostructures) remain valid.

The revised beam "renormalized" bending rigidity [Eq. (9) in Ref. 3] and the effective electromechanical coupling coefficient k_{eff} [Eq. (10) in Ref. 3 redefined from energy considerations] as established in Ref. 1 are, respectively

$$G = YI\left[1 + \frac{d^2}{(\varepsilon_0^{-1} + a)Y} + \frac{Aff'}{(\varepsilon_0^{-1} + a)YI}\right] \quad (1)$$

$$k_{eff} = \frac{\chi}{1+\chi}\sqrt{\frac{\varepsilon}{Y}\left(d^2 + 12\left(\frac{f'}{h}\right)^2\right)} \quad (2)$$

The piezoelectric-flexoelectric interaction term incorrectly found in Ref. 3 vanishes in the revised solution. The sized dependency does occur only because of flexoelectricity.

It is worth to mention that there exists a discrepancy between the flexoelectric constants values determined from *ab initio* calculations and those obtained from experimental data. For example, in the case of $BaTiO_3$ (BT), the flexoelectric constants estimated from *ab initio* calculations[4] are three orders of magnitude lower than the experimental estimates reported by Ma and Cross.[5] In addition, the existence of such a large discrepancy between the *ab initio* calculations[4] and the experimental values[5] was also confirmed by the work of another independent group from Cambridge.[6]

The piezoelectric constant of lead zirconate titante (PZT) is taken from Ref. 7 as $d=-5.4\frac{\mathrm{C}}{\mathrm{m}^2}$. Here, we use the flexoelectric constants values estimated from both *ab initio* calculations on lead titanate in the order of $f=1\frac{\mathrm{nC}}{\mathrm{m}}$ as reported by Ref. 6 and from experimental estimates by Ma and Cross[8] as $f=0.5\frac{\mu\mathrm{C}}{\mathrm{m}}$. We also report the results for the total harvested power in both cases (with flexoelectric constants estimated from *ab initio* calculations[6] (see Fig. 1) and from experiments[8] (see Fig. 2).

Results (Figs. 1 and 2) indicate the same maximum enhancement (200% for short circuit and 30% for open circuit) for the harvested power due to flexoelectricity for both scenarios (with flexoelectric constants estimated from *ab initio* calculations[6] and from experiments[8]). However, the enhancement is seen at different sizes in both cases. In the case of the *ab initio* calculations,[6] the enhancement start at around tens of nanometers and the harvested power peak occurs at around 2 nm. In the

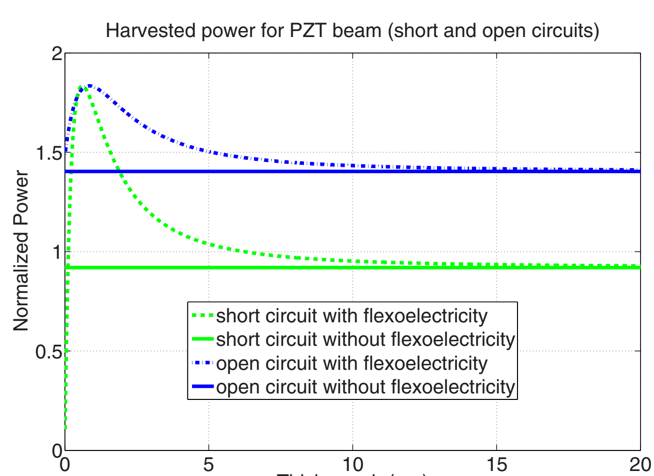

FIG. 1. (Color online) Harvested power as function of beam thickness for short and open circuit resonances with flexoelectric constants estimated from *ab initio* calculations (Ref. 6). Solid lines correspond to the harvested power for classical piezoelectric beam. The dashed and dotted lines show a size dependency of the harvested power which nearly doubles for the short circuit (green or light gray) and is enhanced by 30% for the open circuit (blue or dark gray) when including flexoelectricity.

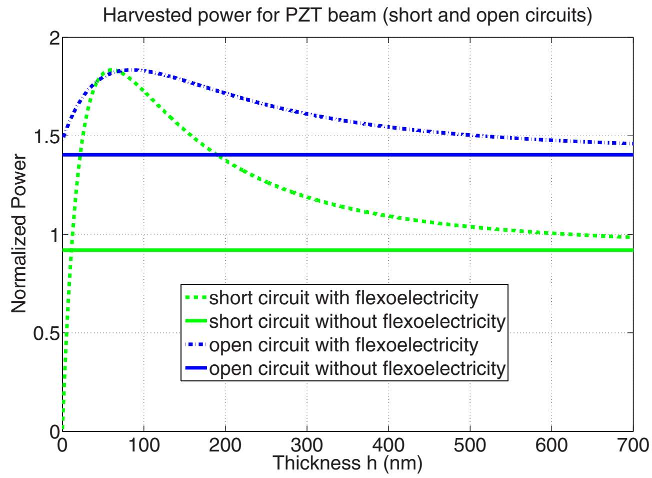

FIG. 2. (Color online) Harvested power as function of beam thickness for short and open circuit resonances with flexoelectric constants estimated from the experimental values of Ref. 8. Solid lines correspond to the harvested power for classical piezoelectric beam. The dashed and dotted lines show a size dependency of the harvested power which nearly doubles for the short circuit (green or light gray) and is enhanced by 30% for the open circuit (blue or dark gray) when including flexoelectricity.

case of the experimental values reported by Ma and Cross,[8] the enhancement commences at much larger sizes around 700 nm and the harvested power peak occurs at around 70 nm.

The discrepancy between the flexoelectric constants estimated from *ab initio* and experiments remains unresolved but the possible reasons behind this discrepancy are discussed briefly in Ref. 4. The enhancement intensity in energy harvesting and the central conclusions remain the same as in the previous publication.[3]

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