Erratum: Strain-Gradient-Induced Polarization in $SrTiO_3$ Single Crystals [Phys. Rev. Lett. 99, 167601 (2007)]

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(Received 21 April 2008; published 16 May 2008)

DOI: 10.1103/PhysRevLett.100.199906 PACS numbers: 77.65.−j, 77.80.Dj, 99.10.Cd

An error was found in the equations for bent beams in Ref. [1]. The correct expressions are

$$\mu_{(001)}^{\text{beam}} = \lambda f_{1111} + (1 + \lambda) f_{1122} \tag{1}$$

$$\mu_{(101)}^{\text{beam}} = \zeta f_{1111} + \xi f_{1122} - 2(1 - \zeta) f_{1212} \tag{2}$$

where $\lambda = -\frac{c_{12}}{c_{11}+c_{12}}$, $\zeta = \frac{2c_{11}c_{44}}{c_{11}^2-2c_{12}^2+c_{11}(c_{12}+2c_{44})}$, $\xi = \frac{2(c_{11}-2c_{12})c_{44}}{c_{11}^2-2c_{12}^2+c_{11}(c_{12}+2c_{44})}$, and c_{ij} are the elastic stiffness coefficients in Voigt notation. These are not linearly independent from the bent plate equations in Ref. [1] or those for $\mu_{(111)}$. Hence, despite the use of different sample geometries and crystallographic orientations, only two independent equations involving f_{1111}, f_{1122}, and f_{1212} can be obtained from bending experiments alone, and additional information is required to find the individual tensor components. Here, we present an alternative calculation. The revised flexoelectric tensor is of the same order of magnitude as initially reported and does not alter the original conclusions [1].

One of the flexoelectric components, labeled here as $\tilde{f}_{44}$, was independently calculated from Brillouin scattering data [2]. It can be related to f_{1212} via

$$f_{1212} = \chi c_{44} \tilde{f}_{44} \tag{3}$$

where χ is the dielectric susceptibility. Using $\tilde{f}_{44}$ from [2], $\chi = 300\epsilon_0$, and the room temperature elastic compliances from [3] gives $f_{1212} = 5.8$ nC/m, which compares very well with the magnitude of the flexoelectric response observed in our bending experiments. This can now be used, together with any pair of the measured μ values, to calculate the remaining flexoelectric tensor components, with the caveats that (i) f_{1212} was obtained from a different set of samples, and (ii) it may contain significant contributions from the dynamic flexoelectric effect [4].

There is a further difficulty in that the anticlastic deformation in the three-point bent samples is not precisely known. While it is common to classify samples into beams (anticlastic bending allowed) and plates (anticlastic bending completely hindered) based on their thickness-to-width ratios (with plates having $t/w \lesssim 1/10$), it was shown by G. F. C. Searl [5] that the important parameter is actually the ratio w^2/tR, where R is the curvature radius. Using this as the relevant parameter suggests that the beam approximation is more appropriate for *all* our samples, due to their small deflection.

However, in a three-point bending setup, some suppression of the anticlastic bending will always be present near the knife edges and the point of loading. Accordingly, the beam equations have to be corrected by a hindrance factor. This factor is not known analytically, and there are very few experimental works quantifying it [6]. The hindrance factor, if not accounted for, leads to a discrepancy between the flexoelectric components calculated using different pairs of sample orientations. We have thus tried to estimate the degree of hindrance by calculating f_{ijkl} for the three different pairs of orientations in our experiment, and tuning the value of the hindrance factor until all three give exactly the same result. In this way, the remaining tensor components are calculated as $f_{1111} \approx +0.2$ nC/m and $f_{1122} \approx +7$ nC/m [5], with a corresponding hindrance factor of about 0.4 (i.e., the average anticlastic bending is only 40% of the theoretical value for an unhindered beam).

As in Ref. [1], we note that while the flexoelectric tensor components can be obtained as described above, the calculated values should be treated as order of magnitude estimates only, due to the uncertainties in the measured μ values arising from the intersample variation, the unknown uncertainty in f_{1212}, and the approximations made in modelling the internal strain distributions. In particular, the small size of f_{1111} and its sensitivity to small changes in the parameters used for its calculation render its sign still uncertain. The revised flexoelectric tensor components are nevertheless comparable to the initially reported values [1], leaving the conclusions of the original paper unaffected.

The authors are grateful to A. K. Tagantsev for valuable discussions.

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