## Comment on "Optical Transitions in Quantum Wires with Strain-Induced Lateral Confinement"

In a recent Letter,[1] Gershoni *et al.* suggest a method for strain patterning of quantum wells to produce quantum wires. They propose that wells grown pseudomorphically on the cleaved edge of a strained-layer superlattice will have laterally modulated lattice constants. This modulation could in principle trap excitons, in analogy to our previously demonstrated technique of "stressor patterning."[2-4] The authors claim to have produced in this way lateral strain modulation of 30–40 meV in the conduction-band edge of GaAs wells. As evidence, they cite excitonic features in photoluminescence and excitation spectra that are redshifted with respect to, and that have polarization anisotropies different from, corresponding features from unstrained portions of the wells.

In this Comment we show that the authors have overestimated the strain modulation in their quantum wells by more than 2 orders of magnitude. We suggest that nonuniform growth on the cleaved edge may provide an alternative explanation for their data.

We calculate the strain modulation for the structure of Gershoni *et al.* by applying continuum elasticity theory, using a standard finite-element method as discussed earlier.[3] A single period of the structure is shown in Fig. 1(a), with our calculated hydrostatic deformation in the GaAs-AlGaAs layers, which creates in regions of expansion the potential wells for excitons.[3,4] The modulation is greatest near the cleaved InGaAs edge and decays rapidly with distance [Fig. 1(b)], as does the shear strain, with an intuitively reasonable decay length of the order of the InGaAs layer width. The lateral volume modulation of $3.3\times10^{-5}$ in the quantum well nearest the cleaved interface yields a hydrostatic band-gap modulation of 0.28 meV [Fig. 1(c)], *more than 2 orders of magnitude less than that estimated by Gershoni et al.* This discrepancy arises primarily from their assumption that the strain modulation does not decay significantly from the interface to the quantum wells. In addition, even at the interface the strain modulation is less than their estimate, a consequence of relaxation and redistribution of strain in the InGaAs layer near its cleaved edge.

An alternative explanation for their data might be found in nonuniform growth of the GaAs well. A lateral variation in surface composition alone is sufficient to cause a variation in lateral growth rate, leading to surface roughening and the formation of wires.[5] Similar arguments may be used to anticipate similar phenomena for growth on a cleaved [110] surface with alternating regions that differ in composition, strain, and lattice parameter. Indeed, the Stokes shifts observed for the wells grown on the strain-modulated surface, 9 and 50 meV, respectively, for the 8- and 3.4-nm-wide wells, are significantly larger than the 3-meV shift for the well grown on the unstrained surface. Their data demonstrate that width fluctuations are enhanced for wells grown on the strain-modulated surface.

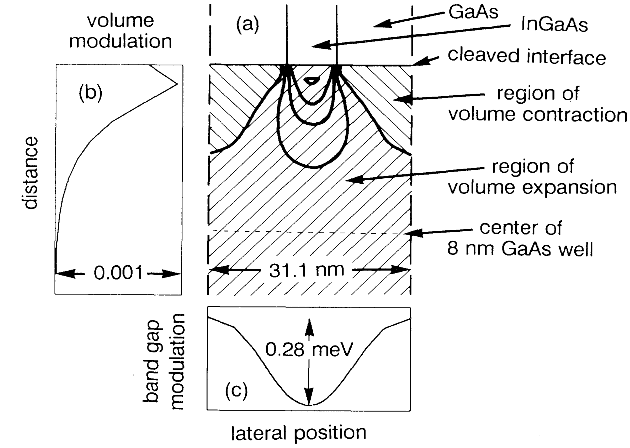


FIG. 1. (a) Sketch to scale of one period of the structure of Gershoni *et al.* (Ref. 1), with a contour plot of the volume expansion. (b) Modulation of the volume expansion as a function of depth from the center of the cleaved interface. (c) Lateral hydrostatic modulation of the band gap in the GaAs well. Length scales in (a), (b), and (c) are identical.

Finally, we note that strong, transition-dependent polarization anisotropies occur if uniform but anisotropic strain is present in the well,[4] and is not necessarily evidence for quantum wire confinement. Polarization anisotropies may be expected for anisotropic well-width fluctuations also.

In conclusion, our calculation of strain in the structure of Ref. 1 supports the intuitive notion that lateral strain modulation of the cleaved interface decays too rapidly with distance to produce significant lateral band-gap modulation in the underlying quantum wells. We suggest that the authors look to an alternative explanation, such as unusual growth phenomena on this nonstandard substrate, to explain their data.

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[1]D. Gershoni, J. S. Weiner, S. N. G. Chu, G. A. Baraff, J. M. Vandenberg, L. N. Pfeiffer, K. West, R. A. Logan, and T. Tanbun-Ek, Phys. Rev. Lett. **65**, 1631 (1990).

[2]K. Kash, J. M. Worlock, M. D. Sturge, P. Grabbe, J. P. Harbison, A. Scherer, and P. S. D. Lin, Appl. Phys. Lett. **53**, 782 (1988).

[3]K. Kash, R. Bhat, Derek D. Mahoney, P. S. D. Lin, A. Scherer, J. M. Worlock, B. P. Van der Gaag, M. Koza, and P. Grabbe, Appl. Phys. Lett. **55**, 681 (1989).

[4]K. Kash, J. M. Worlock, A. S. Gozdz, B. P. Van der Gaag, J. P. Harbison, P. S. D. Lin, and L. T. Florez, Surf. Sci. **229**, 245 (1990).

[5]H. M. Cox, D. E. Aspnes, S. J. Allen, P. Bastos, D. M. Hwang, S. Mahajan, M. A. Shahid, and P. C. Morais, Appl. Phys. Lett. **57**, 611 (1990).