X-Ray Absorption Spectroscopy Measurement of Strain-Band Structure Relationship in Si Nanomembranes*

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The influence of in-plane biaxial strain on the conduction bands of Si is explored using elastically strained Si(001) and Si(110) nanomembranes and high-resolution x-ray absorption measurements with electron yield detection. From the derivative of the L_{II,III} absorption spectra, the strain-induced energy shifts of the conduction band minimum (Δ) and two higher conduction band valleys (L_1 and L_3) are clearly resolved as shown in Fig.1. The energy splittings of the Δ and L valleys due to the change in the crystal symmetry can also be found by fitting the measured spectra of strained Si(001) and Si(110) with spectra created from the line shapes of an unstrained Si reference with appropriate intensity ratios. From the relationship between the conduction band shifts and strain, we find the deformation potentials of the Δ and L valleys. These agree quantitatively with current theories. Our work reports the first deformation potential measurement of the L valley in Si.

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**Figure 1:** First-derivative XAS spectra from Si(001) with strain from 0 to 0.95%. The tensile strain shifts the Si2p-Δ and Si2p-L_3 optical transitions to higher energy and the Si2p-L_1 transitions oppositely to lower energy.