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Effect of Electric Field on Optical Phonon Modes of Solid CO

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We examed the effect of applied electric field on collective phonon modes of a CO solid crystal. A strong electric field (~10^8 V/m) was applied across a thin CO film grown on a metal substrate at 7 K by using the ice film capacitor method. Reflection absorption infrared spectroscopy (RAIRS) was used for monitoring the optical phonon modes of a CO film, where a longitudinal optical (LO) mode appeared at 2143 cm^{-1} and a transverse optical (TO) mode appeared at 2139 cm^{-1}. The peak position of LO mode was blue-shifted by the external field and that of TO mode was red-shifted. This field-induced LO-TO splitting may occur as a result of a vibrational Stark shift of the phonon modes which have specific directions of progression in CO crystal domains. To explore the origin of the LO-TO splitting, we studied the effect of electric field on diluted ^{13}CO molecules in a ^{12}CO film, where the ^{13}C-O vibration is isolated from the intermolecular coupling of ^{12}CO vibrations in the lattice. When the external field was applied, the decoupled ^{13}C-O stretching appeared as a single peak and showed a vibrational Stark broadening because ^{13}CO molecules have an isotropic orientation in the lattice. These observations indicate that the field effect on collective phonon motions of CO molecules in the crystal causes the LO-TO splitting.

Significance statement

The effect of applied electric field on collective phonon modes of a CO solid crystal was examined by using the ice film capacitor method. The field-induced LO-TO splitting was observed as a result of a vibrational Stark shift of the phonon modes.

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