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A Novel Vibrational Spectroscopic Study of a Single Molecule using an STM – Measurement and Selection rules of Action spectroscopy YOUSOO KIM, RIKEN, YASUYUKI SAINO, Tohoku Univ., TOSHIRO OKAWA, Gakushuin Univ., TADAHIRO KOMEDA, Tohoku Univ., HIDEMI SHIGEKAWA, Univ. of Tsukuba, MAKI KAWAI, Univ. of Tokyo, RIKEN — The excitation of molecular vibration by means of the inelastically tunneled electrons from the tip of a scanning tunneling microscope (STM) can lead to various dynamical processes at surfaces. In addition, inelastic electron tunneling spectroscopy with the STM (STM-IETS) is now applicable to the vibrational spectroscopy of the individual molecules. The vibrational spectrum of a single molecule provides useful information not only for the chemical identification of the molecule but also for investigating how molecular vibration can couple with the relevant dynamical processes. Inelastically tunneled electrons from the STM were used to induce vibrationally mediated motions of a single *cis*-2-butene molecule among four equivalent orientations on Pd(110) at 4.7 K. Action spectrum obtained from the motions clearly detects more vibrational modes than STM-IETS. We demonstrate the usefulness of the action spectroscopy as a novel single molecule vibrational spectroscopic method. We also discuss its selection rules in terms of the resonance tunneling.

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