Phonon Spectroscopy of Tunneling States in NaCl:OD^-

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It is known since long, that OH^- and OD^- defects form tunneling states with $\langle 100 \rangle$ symmetry in certain alkali halide crystals. Surprisingly, recent measurements of the dielectric susceptibility and of the infra-red absorption showed that the tunnel splitting of the heavier isotope OD^- is larger by a factor 1.4 compared to that of OH^-, although one would expect the opposite behavior from the difference in mass of hydrogen and deuterium. Because of selection rules, these anomalous findings are yet only proven for those levels accessible in dielectric experiments. We have investigated NaCl:OD^- by means of phonon spectroscopy with superconducting tunnel junction in order to obtain additional information on the level scheme of OD^- tunneling states in NaCl. Since the selection rules applying in dielectric measurements are different from those in elastic experiments it becomes possible to study different transitions within the level scheme. Our experiments have been performed at 4 K using a Sn-junction as transmitter and a Al-junction as detector. Indeed we find a resonance, which clearly can be attributed to OD^- defects. A comparison with earlier measurements by Kinder and Windheim on OH^- in NaCl leads to the conclusion that the anomalous isotope dependence is also found for the levels which are involved in phonon transitions. We present the experimental results and discuss possible reasons for this anomalous isotope dependence.