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Uniaxial Stress Effects on Parity-Forbidden Transitions in NaCl:Cu^+ and KCl:Ag^+

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The temperature dependence of the stress-induced dichroism in the UV absorption bands of NaCl:Cu^+ and KCl:Ag^+ is investigated. The experiments are explained by a frequency splitting of the IR active resonance mode and an off-centre displacement of the defect in the excited state. The value of the quadratic electron–lattice interaction is determined.

Die Temperaturabhängigkeit des durch axialen Druck verursachten Dichroismus in den UV-Banden von NaCl:Cu^+ und KCl:Ag^+ wird untersucht. Die Experimente lassen sich durch eine Frequenzaufspaltung der IR-aktiven Resonanzschwingung und durch eine „off-centre"-Verschiebung der Störstelle im angeregten Zustand erklären. Der Wert der quadratischen Elektron–Gitter-Wechselwirkung wird bestimmt.

1. Introduction

The UV absorption bands of Cu^+ and Ag^+ in alkali halides show a characteristic temperature dependence, which was carefully investigated by Fußgänger et al. [1, 2]. The defect ion replaces a cation on a normal lattice site with point symmetry O_h. The electronic transitions have been interpreted as parity-forbidden electric dipole transitions $(n-1)\,d^{10} \rightarrow (n-1)\,d^9 n\,s$ ($n = 4$ for Cu^+, $n = 5$ for Ag^+). Odd parity lattice modes destroy the inversion symmetry of the defect and the transitions become allowed by mixing of even and odd electronic states [3]. Observed deviations from the expected temperature dependence of the oscillator strength gave further information about the defect properties. In NaCl:Cu^+ a small "off-centre" displacement of the Cu^+ ion in the lattice cell and a thermal contraction of the cell at higher temperature has been proposed [1, 4]. In KCl:Ag^+ two phonon processes in the high-temperature range cause an additional increase of the oscillator strength proportional to the square of the temperature [2].

To investigate the interactions of the defect electrons with cubic distortions of the lattice, the UV absorption of NaCl:Cu^+ was measured under hydrostatic pressure at room temperature [4] using a method due to Drickamer [5]. Under a hydrostatic pressure of 1 kbar, the relative shift of the peak energy $\Delta E/E$ was found to be 1.5×10^{-3} and a small decrease of the oscillator strength was observed [4]. In the present work we report on the effects of uniaxial stress (interactions with noncubic distortions of Γ_3^+- and Γ_5^+-symmetry) on the UV bands of NaCl:Cu^+ and KCl:Ag^+ at different temperatures.

2. Measurements

We measured the difference in the absorption constant K for light polarized parallel and perpendicular to the stress axis by a rotating polarizer using a lock-in technique [6, 7]. The size of the samples was about $7 \times 5 \times 1$ mm³. To avoid