Brillouin and Raman scattering studies of the isotopically induced ferroelectric phase transition of SrTi\textsuperscript{18}O\textsubscript{3}

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The quantum paraelectric SrTiO\textsubscript{3} has attracted a lot of interest of many researchers since the quantum-mechanical stabilization of the paraelectric phase below 4K was pointed out as a quantum effect on the polarization fluctuation.\textsuperscript{1)} Recently a ferroelectric phase transition has been reported in the SrTiO\textsubscript{3} crystal exchanged of isotope \textsuperscript{18}O for \textsuperscript{16}O.\textsuperscript{2)} The difference of mass between \textsuperscript{16}O and \textsuperscript{18}O seems to suppress the quantum fluctuations and to bring divergence of the spatial correlation of the fluctuating polarization at the paraelectric-ferroelectric phase transition. In the present study, the dynamical mechanism of the ferroelectric phase transition of the isotopically exchanged SrTiO\textsubscript{3} has been studied by both of the Brillouin- and Raman scatterings.\textsuperscript{3-5)} The exchange rate of the isotope \textsuperscript{18}O is 87% which gives the ferroelectric transition temperature T\textsubscript{c}=24K.\textsuperscript{2)}

Brillouin scattering study found anomalous temperature dependence of the acoustic mode near T\textsubscript{c}; a transverse mode shows a softening behavior in contrast to no anomaly of the longitudinal c\textsubscript{33} mode. The rather complicated behavior of the acoustic modes near T\textsubscript{c} has been elucidated. A strong central component appeared in the Brillouin scattering spectra suggests existence of the dynamical cluster near T\textsubscript{c}. The isotope effect on the doublet problem is discussed.

Raman scattering study elucidates a broad spectrum characteristic for the ferroelectric micro-region (FMR) reported previously for SrTi\textsuperscript{16}O\textsubscript{3}.\textsuperscript{5,6)} The size of FMR increases anomalously when temperature approaches to T\textsubscript{c} in the paraelectric phase. The soft mode spectra are not clear below T\textsubscript{c}, though every soft-ferroelectric mode should be Raman active in the ferroelectric phase.

The ferroelectric phase transition induced isotopically in SrTiO\textsubscript{3} seems to be caused by somewhat complicated cluster dynamics rather than by homogeneous fluctuation of polarization.

\textsuperscript{1)} K.A. Muller and H. Burkard: Phys. Rev. B\textsuperscript{19}(1979)3593.
\textsuperscript{6)} H. Uwe, H. Yamaguchi and T. Sakudo: Ferroelectrics \textbf{96}(1989)123.