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**A phonon fluctuation state in the stuffed tridymite-type oxides $Ba_{1-x}Sr_xAl_2O_4$** YUI ISHII, Osaka Prefecture Univ, SHOGO KAWAGUCHI, JASRI/SPring-8, HIROFUMI TSUKASAKI, YUHYA OUCHI, SHIGEO MORI, Osaka Prefecture Univ — The paraelectric phase (space group $P6_322$) of the stuffed tridymite-type ferroelectric $BaAl_2O_4$ has recently been reported to possess the energetically competing low-energy phonon modes at the M- and K-points, both of which soften at $T_C$ simultaneously [Y. Ishii et al., Phys. Rev. B 93, 134108 (2016).]. The M-point mode condenses at $T_C$=450 K, giving rise to the low-temperature ferroelectric phase ( $P6_3$), whereas the K-point mode is electrostatically unfavorable and just disappears below $T_C$. In this study, we investigated the thermal diffuse scatterings in the electron diffraction and the dielectric properties of $Ba_{1-x}Sr_xAl_2O_4$ ($x = 0 - 0.5$). We present that $Ba_{1-x}Sr_xAl_2O_4$ system exhibits a "fluctuating" state, in which the M-point soft mode does not condense but survives and fluctuates down to low temperature, below $T^* \sim 200$ K. Although the K-point soft mode disappears below $T^*$, the $P6_322$ crystal structure is retained at temperatures down to 15 K. The wave vector of the M-point diffuse scatterings is temperature dependent below $T^*$ and loses commensurateness as the temperature decreases. This result indicates that the fluctuation in the wave vector of the M-point mode increases at low temperatures.

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