Dielectric anomaly and structural change related to the Jahn-Teller transition in DyVO$_4$

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The RVO$_4$ system has been studied as dielectrics for several decades. Among them, DyVO$_4$ having Dy$^{3+}$ (4$f^9$) and V$^{5+}$ (3$d^0$) ions shows the Jahn-Teller (JT) transition at $T_D = 14$ K due to the interaction between 4$f$ electrons on Dy sites and the lattice. As a result, the lattice distorts from the $I4_1$ $amd$ tetragonal to the $Imma$ orthorhombic structure and ferroquadrupolar ordering occurs below $T_D$. We measured the dielectric constant of a single crystal of DyVO$_4$ and observed a distinct dielectric anomaly around $T_D$. To clarify the origin of the dielectric anomaly, we performed detailed single crystal structure analyses. Our results suggest that the JT distortion shifts the position of oxygen ions relative to a V ion and then local polarization of a VO$_4$ tetrahedron is induced below $T_D$. We also report the structural domain control causing remarkable magnetocapacitance effects by applying a relatively small magnetic field ($\sim 0.1$ T), which is attributed to the strong spin-orbit coupling of Dy 4$f$ electrons.

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Date submitted: 19 Nov 2009

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