Chromium Centers in $SrTiO_3$: Properties, Problems and New Data

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Doping by spectroscopic and functional impurities is widely used in a number of studies and applications of ABO_3 perovskite-like oxides. We present a review of the most significant results and new studies of the popular model representative of ABO_3 ferroelectric (FE) oxides with TO1 soft phonon mode: $SrTiO_3$ (STO) doped by Cr^{3+}(3d) model TrM impurities. Presence of the low-lying temperature-dependent TO1 soft mode and orbital degeneracy of the ^2E_g state of Cr^{3+} lead to very unusual "dielectric related" temperature shift of the zero-phonon emission *R*- line ($^2E_g \rightarrow {}^4A_{2g}$) and local configuration instability of Cr^{3+} in photo-excited ^2E_g state [1,2]. Valuable information about phonon modes can be obtained from investigations of vibronic sidebands of *R*- lines. Because Cr unavoidably contaminates STO, the temperature shift of the *R* lines can be used for detection and studies of phase transition in STO based crystals, ceramics, thin films (e.g. [3] for STO:Ca). Just recently the instability and low-temperature minimum of the *R*-emission line energy was found in STO:Cr nanoparticles of the size ~ 13 and 20 nm [4]. This feature can be connected to FE transition in the particle surfaces with the formation of a closed configuration of spontaneous polarization. An important effect of Cr doping was shown in the recent EPR studies of Cr centers controlling a reproducible bistable switching of the leakage current in STO:Cr based structures [5]. We also present new EPR studies of the Cr centers structure depending on thermal treatment of crystals, ratio and stoichiometry of batched Sr and Ti host ions [6].

References

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