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$LaAlO_3/SrTiO_3$ ヘテロ接合界面における光キャリア局在化ダイナミクス

Dynamics of photocarrier relaxation into localized states at the $LaAlO_3/SrTiO_3$ heterointerface

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Two-dimensional electron gas (2DEG) systems have been reported at the $LaAlO_3/SrTiO_3$ (LAO/STO) heterointerface [1], and their unique electronic properties have attracted much attention. Recently, it has been pointed out that free and localized carriers coexist at the heterointerface and they play a critical role in the conduction mechanism of LAO/STO system [2]. In addition, we found that the PL spectrum of electron-doped $SrTiO_3$ bulk crystal has both a broad band and sharp band-edge peaks, which indicates that the coexistence of free carriers in band states and localized photocarriers in localized states [3,4]. These results mean that the carrier localization mechanisms might be the key factors that determine the electronic properties of $SrTiO_3$ and $SrTiO_3$-based heterostructures. Here, we report on the relaxation dynamics of electrons in an n-type LAO/STO heterointerface and bulk electron-doped $SrTiO_3$ crystals studied by femtosecond transient absorption (TA) measurements. TA measurements were performed by a standard pump-probe technique using a wavelength tunable Yb:KGW laser system, where the fundamental light (1.20 eV) was used as a probe pulse.

In bulk $SrTiO_3$, we observed a broad TA band in the infrared region, indicating the localized states of the carriers. After photoexcitation, the TA signal gradually increases with the rise time of several tens of picoseconds. We conclude that the rise time corresponds to the localization time of free electrons. Similar TA signal is also observed in the LAO/STO heterostructure. Surprisingly, we found the extremely long localization time at the heterointerface compared to bulk $SrTiO_3$ crystals. We will present the TA dynamics of LAO/STO heterostructure under different excitation photon energy (or penetration depth) in comparison with electron-doped $SrTiO_3$ bulk crystals, and discuss the mechanism of the slowing down of carrier relaxation processes into localized states.

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