Low-energy excitations and electron-phonon coupling in oxide thin films

tutorial

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Abstract

Phonons and their softening are key elements for the basic understanding of many solid-state phenomena. In polar media like oxides, optical phonons are important since they carry substantial dynamical dipole moments and couple efficiently to electromagnetic low-energy excitations. In ferroelectric and multiferroic complex oxides, the softening of optical phonons might indicate imminent phase transitions. The complex dielectric function known also as complex permittivity is a concept used to describe such low-energy excitations. The presence of charge carriers as in metallic or doped oxides will add a plasmonic response.

In this talk, I will discuss the surface and thin film dielectric function for the perovskite oxides $BaTiO_3$, $SrRuO_3$, $SrTiO_3$, and $KTaO_3$ and its quantitative determination by surface vibrational spectroscopy. It will be shown that phonons and plasmons form specific phonon-polaritons and plasmon-polaritons at the interface. The influence of different doping levels on the full dielectric response will be discussed and used to follow in-situ doping level changes quantitatively. The electron-phonon coupling will be discussed with respect to the formation of a two-dimensional electron gas at the surface of $SrTiO_3$ and the phonon line shape for $SrRuO_3$.

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