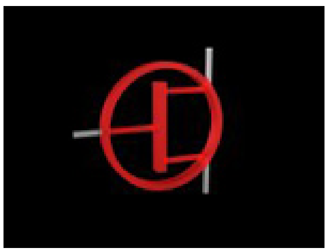
Field-effect transistor based on $KTaO_3$ perovskite

May 1 2004



Solid state devices based on transition metal oxides, especially with perovskite related structure, are very promising candidates for the next generation electronics due to their rich variety of functions such as superconductivity, ferroelectricity, and colossal magnetoresistance. K. Ueno et al. from Correlated Electron Research Center (CERC) in Japan report in the last issue of Applied Physics Letters (Vol. 84, No. 19, pp. 3726–3728) about fabrication of an n-channel accumulation-type field-effect transistor utilizing a $KTaO_3$ single crystal as an active element and a sputtered amorphous Al_2O_3 film as a gate insulator. The device demonstrated an ON/OFF ratio of 10^4 and a field-effect mobility of 0.4 cm^2/V s at room temperature, both of which are **much better than those of the $SrTiO_3$** FETs reported previously.

The field-effect transistor (FET) is the most fundamental device among all solid state devices based on transition metal oxides, and thus the fabrication of FETs using perovskite-related oxides for conducting channels is a first step in a large movement towards oxide electronics. Nevertheless, only a small number of perovskite FETs with relatively low mobilities have been reported so far.

$KTaO_3$, an n-type semiconductor with a band gap of 3.8 eV, which, in single crystalline form, exhibits a relatively higher mobility of 30 cm^2/V s at room temperature than other perovskites.

The FET fabricated on the heat-treated surface of a $KTaO_3$ single crystal showed accumulation-type behavior and reproducible n-channel transistor characteristics with a field-effect mobility more than 0.4 cm^2/V s and an ON/OFF ratio greater than 10^4 at room temperature. The field-effect mobility was almost temperature independent down to 200 K. These results indicate that the Al_2O_3/$KTaO_3$ interface is worthy of further investigations as an alternative system of future oxide electronics.

Authors have demonstrated that $KTaO_3$ is one of the most promising materials for perovskite FET technology. This strongly inspires future research into oxide electronics.