Designing metal oxide heterostructures for solar water splitting

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Background
Advantages of heterostructures for solar water splitting

- Various techniques to tune crystalline defects.
  - Easy to fabricate various heterostructures.

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Oxygen vacancies are the active sites for solar water splitting

Advantages of thin film
- Easy to fabricate various heterostructures.
- Various techniques to tune crystalline defects.

Results
Growth rate dependence of anatase TiO$_2$ (40 nm)/LaAlO$_3$ (001)

- Resistivity depends on the growth rate. Carrier density is dominant.

Photoluminescence

- Luminescence of V$_O$ coupled self-trapped exciton (STE) depends on the growth rate.

Frequency dependence of LaAlO$_3$ (15 nm)/TiO$_2$ (40 nm)/LaAlO$_3$ (001)

- TiO$_2$ degradation was suppressed at slow growth rate of LaAlO$_3$.

Future plan
Ionic structure of LaAlO$_3$

- TiO$_2$, LaAlO$_3$, H$_2$O

Dipole effect of LaAlO$_3$

- CB, H$^+$/H$_2$, VB

Band alignment tuning.

Summary
We optimized the growth rate pursuing the kinetic conditions to improve crystalline quality in anatase TiO$_2$ thin films.

1. The density of oxygen vacancies in anatase TiO$_2$ thin film is controlled by growth rate modulation.
2. The degradation of TiO$_2$ crystalline quality by LaAlO$_3$ capping was suppressed at slow growth rate.