In situ reversible tuning of resistance of $LaVO_3$ thin films via ferroelastic strain induced by PMN-PT single crystals

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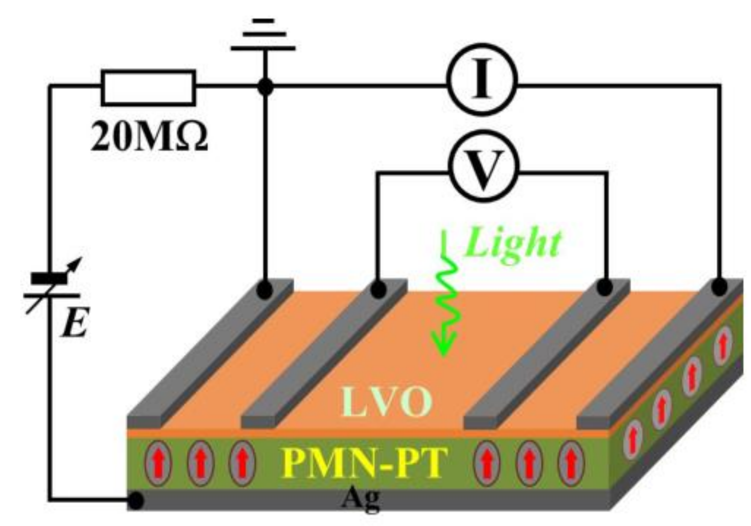
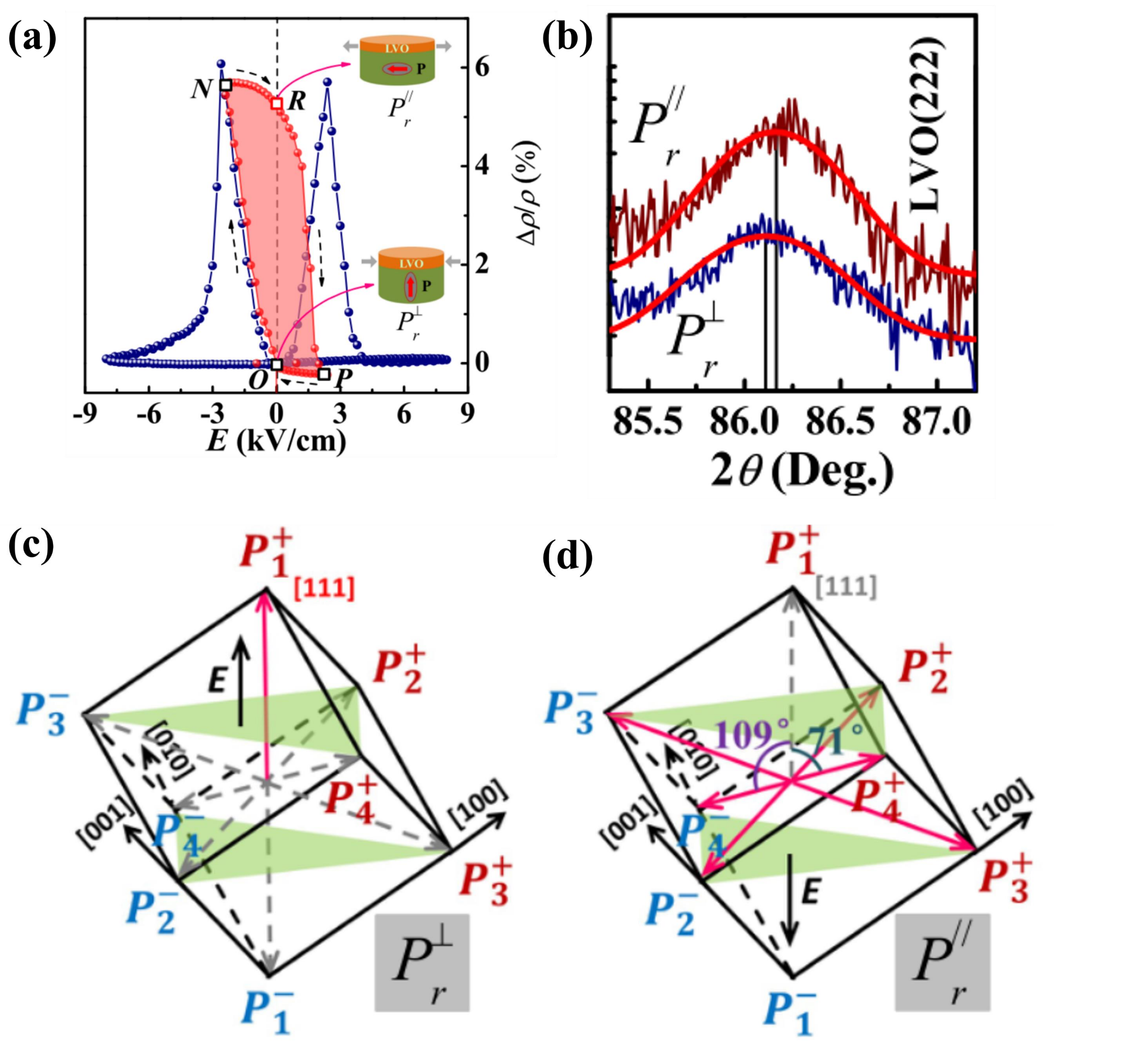
Introduction

The macroscopic physical properties and functionalities of strongly correlated complex oxides usually originate from and depend sensitively on microscopic interactions, which can be controlled by an external stimulus. In this work, $LaVO_3$(LVO)/PMN-PT heterostructures was fabricated by PLD to investigate the light and electric field co-control of resistance switching. The electric-field induced strain-mediated electroresistance response can be effectively tuned by light illumination. This, together with the electric-field-tunable photoresistance effect, demonstrates strong correlation between the light and the electric field, which is essentially mediated by lattice-charge-orbital coupling.

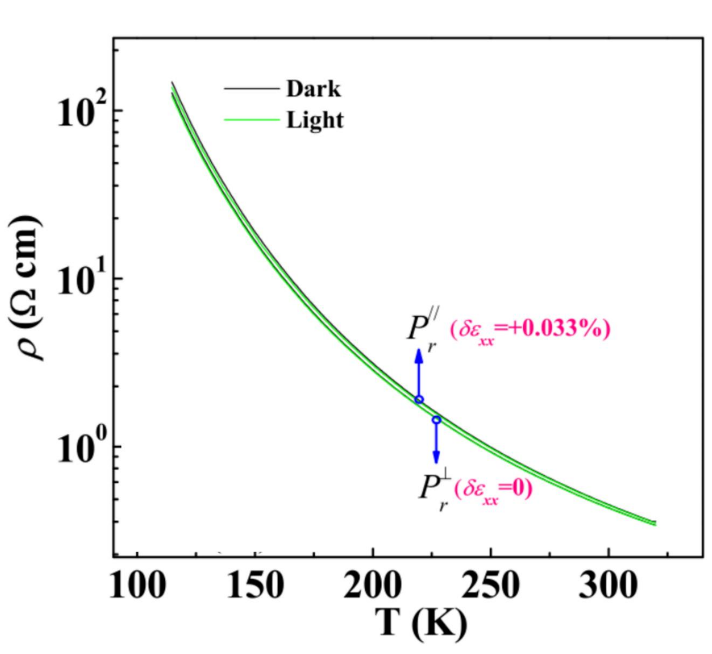


Mediated by strain-driven coupling



- Highly quality (001)-oriented epitaxial LVO thin film.
- The resistance evolution in the LVO film is induced by the electric-field-induced lattice strain in the PMN-PT substrate.

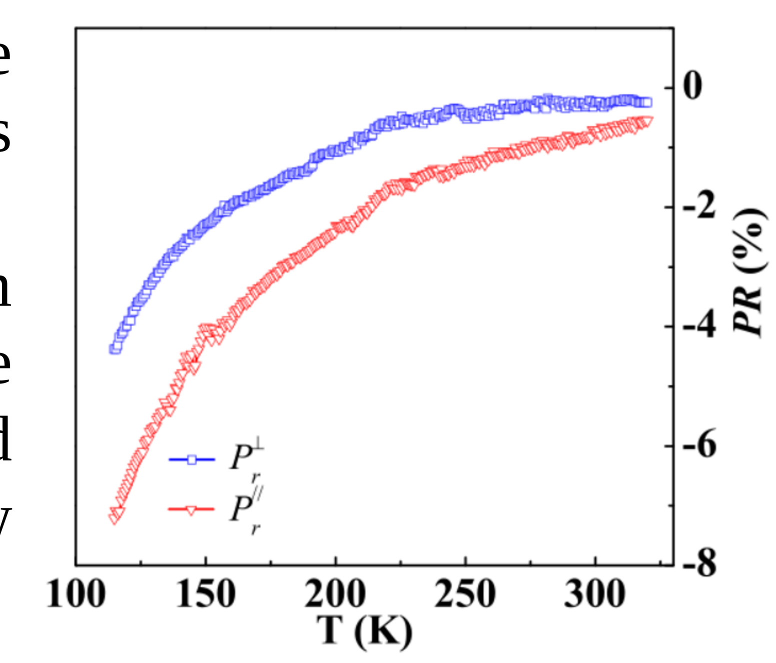
Temperature dependence of the resistance



- The resistance increases with decreasing temperature.
- The in-plane tensile strain increases the film resistance.
- The resistance decreases with light illumination.

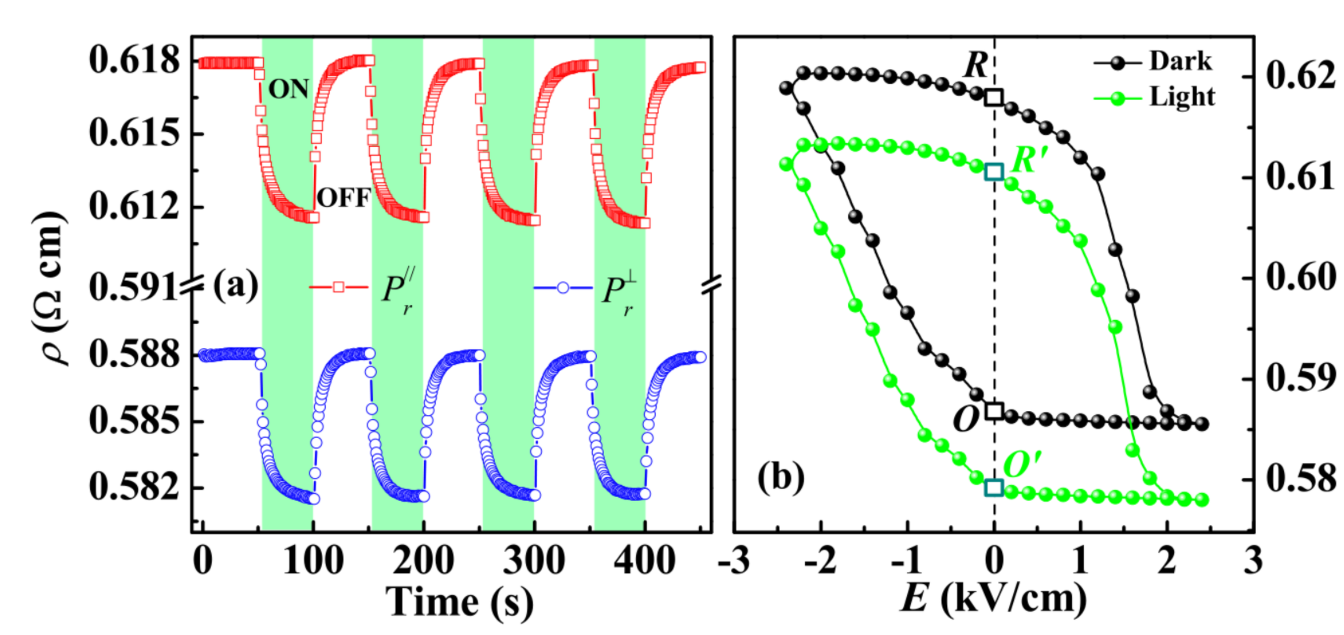
Electric-field controlled PR effect

- The negative photoresistance (PR) increases in magnitude as temperature decreases.
- The polarization is rotated from the $P_r^{\perp}$ to the $P_r^{//}$ state, and the magnitude of the PR is enhanced considerably, especially at low temperatures.



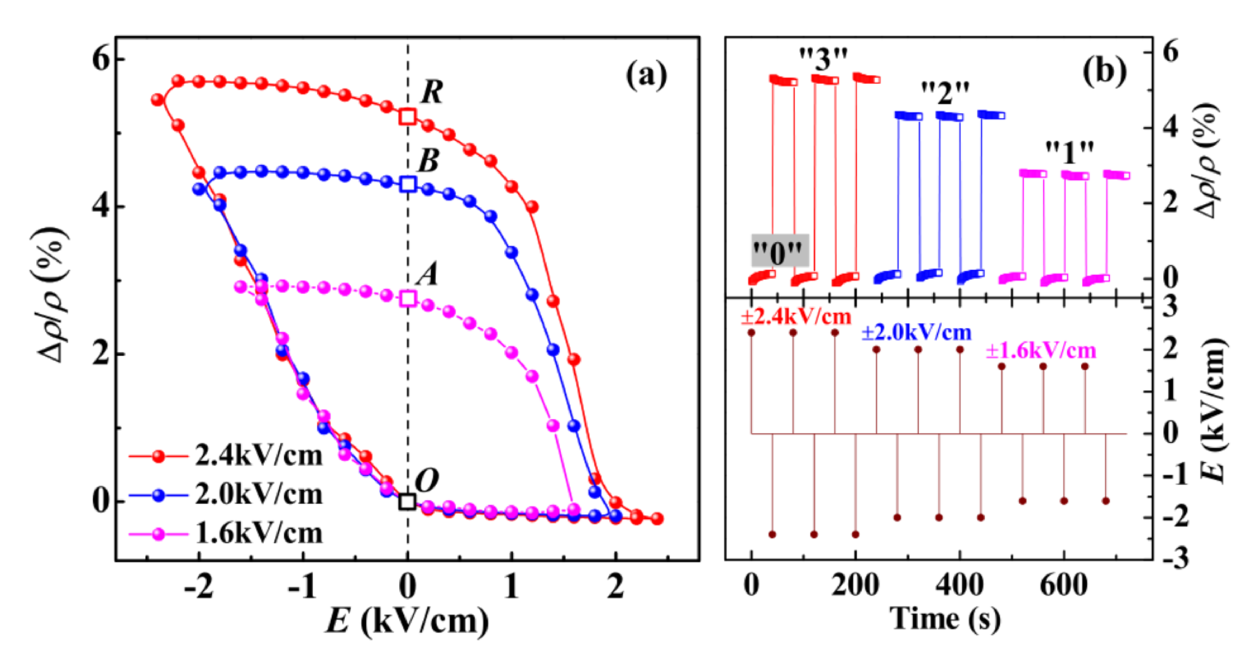
Here, PR is defined as PR=R_{light}−R_{dark} / R_{dark}

Dynamic tuning of resistance by light



- The resistance exhibits the photoinduced relaxation character with the light on and then restores the original value after the light is off.

Nonvolatile resistance switching



- Four nonvolatile resistance switching of the LVO film can be achieved by a sequence of pulse electric fields.

Conclusion

- The resistance increases with decreasing temperature, and associated with the polarization switching from the $P_r^{\perp}$ to the $P_r^{//}$ state.
- The resistive switching hysteresis loops for the two irradiation conditions exhibit similar patterns, signaling that the ferroelastic domain switching dynamics is independent on the photoexcitaion.
- Together with the optically controlled electro-resistance response, our findings provide a unique approach to realize multifield tuning of resistance in complex oxide heterostructures, which allows for the integration of extra functionality (e.g., a light sensor) in nonvolatile memory systems.

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