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複雜性氧化物的光調控：光致伸縮材料與光控多鐵記憶體的開發與應用

Photonic Modulations of Complex Oxide Functionalities: Photostrictive $SrIrO_3$ Films and Multiferroic $BiFeO_3$ Films

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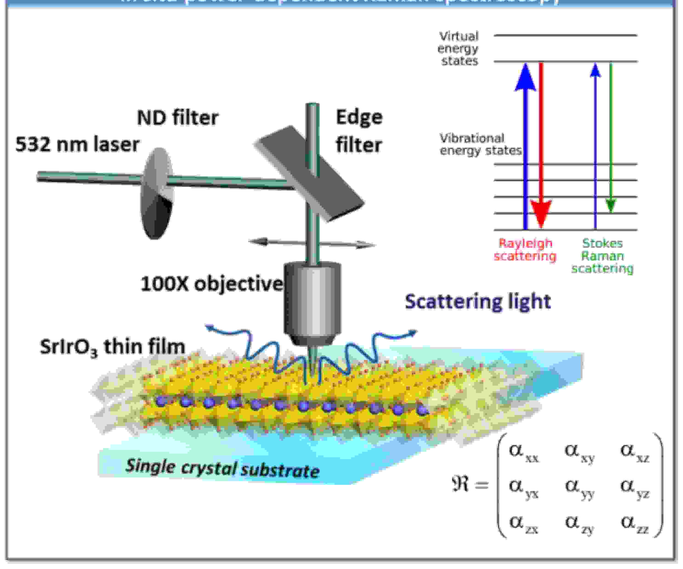
研究重點

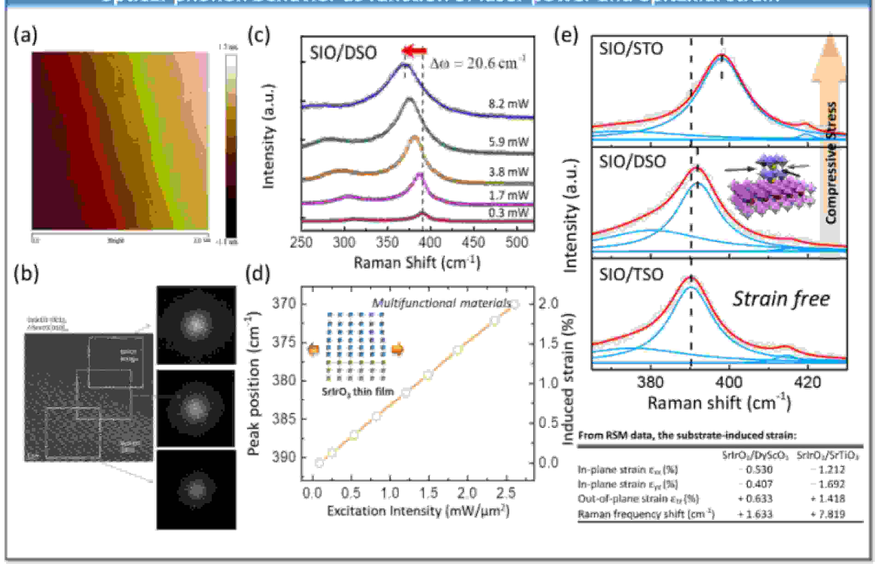
Complex-transition metal oxide materials have caught significant attention in the past decade owing to their broad spectrum of intriguing functionalities, such as high temperature superconductivity, multiferroics, colossal and magneto-resistance, and offer tremendous opportunities to develop next-generation electronic devices. Researches have been devoted to the modulation of these emergent phenomena among complex oxides via external stimuli. Thanks to the interplays of lattice, charge, orbital, and spin degrees of freedom in strongly correlated oxides, the correlated phenomena would be controlled by biasing one of these degrees of freedom, usually through the application of electric, magnetic or stress field. Therefore, the development of additional factor to modulate the lattice, charge, orbital, and spin degrees of freedom has gained more and more demand to cooperate with the existing approaches. In this research, we unveil the possibility to control the emergent phenomena via the stimuli of light. A core novel material, strontium iridates ($SrIrO_3$), which exhibits giant photostriction (~2 % change in lattice) under proper light illumination, is well-developed. At the same time, a light-driven ferroelectric/anti-ferromagnetic/ferromagnetic memory is also demonstrated in multiferroic mixed-phase $BiFeO_3$ system, which is a great achievement in the development of non-volatile multifunctionalities modulation via all-optical control method. After much attention in the detailed studies on the origin and related mechanism of light-driven multifunctionalities, most important goal in future work will be to incorporate these developed novel photosensitive materials with other strongly correlated systems, such as CMR, superconductor, multiferroic, and charge-ordered systems, in the hope of realizing photonic modulation of the fascinating strongly correlated phenomena.

研究成果

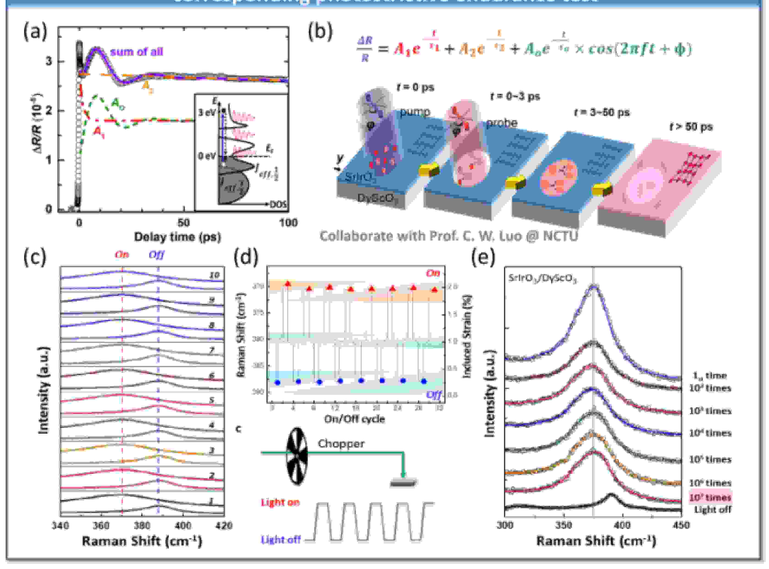
Schematic diagram of laser illumination system and *in situ* power-dependent Raman spectroscopy



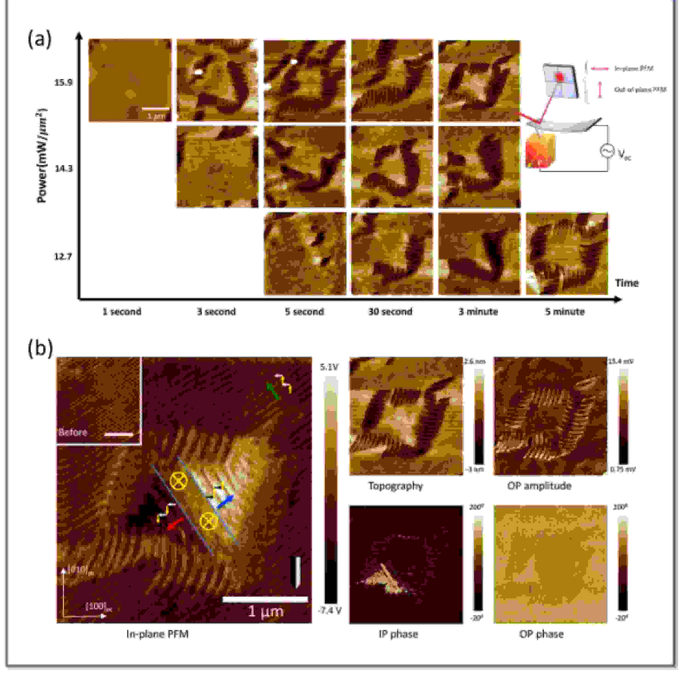
Quality characterization of photostrictive $SrIrO_3$ films and the evolution of optical-phonon behavior as function of laser power and epitaxial strain



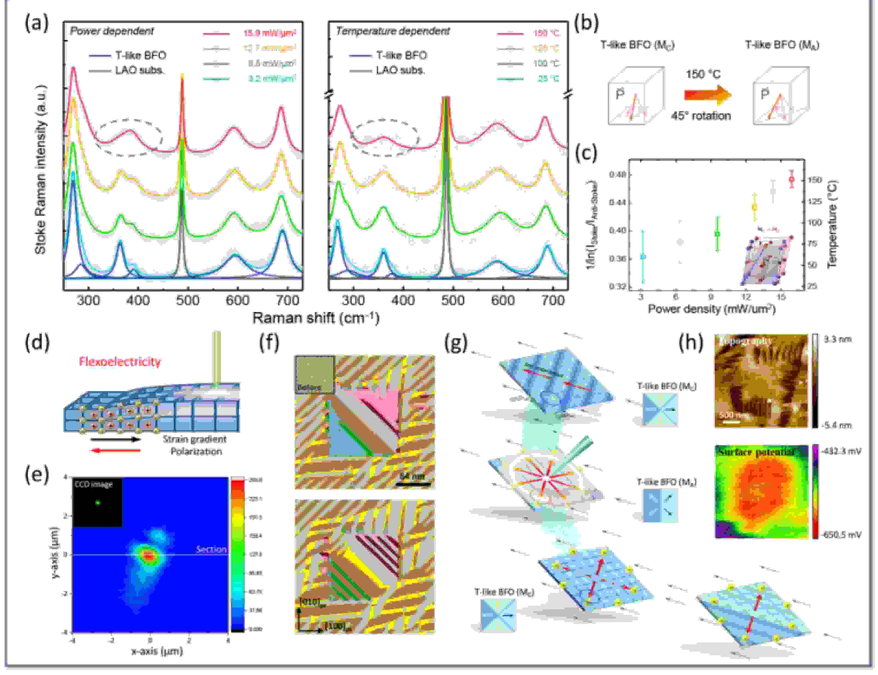
Ultrafast dynamics of coherent acoustic phonons (CAP) of SIO films and corresponding photostrictive endurance test



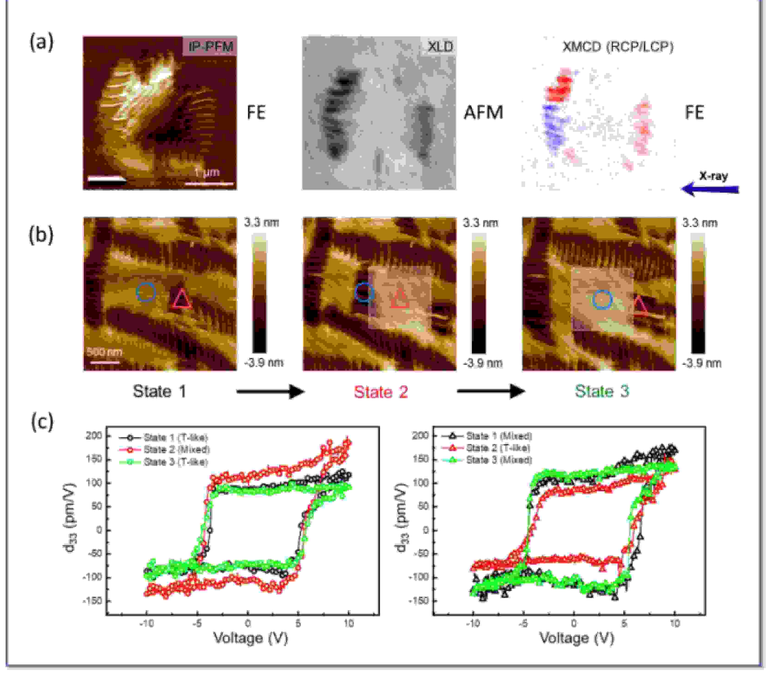
Optical modulation of the highly strained BFO thin film and corresponding changes in ferroelectric domain configuration



Local temperature determination and phase-field simulations of flexoelectric-driven domain structure evolution



Deterministic optical control of multiferroicity and piezoelectric property in mixed-phase BFO.



研究生活與心得

現在是開始做研究的第六年了，若要我憶起啟程時最為深刻的一件事，結果卻是當專題生時與實驗室夥伴熬夜取光譜整整一週，然後夥伴轉去做理論，而我仍留下來努力分析數據。那時的我便知道此路是挫折且坎坷的，而關鍵在於對於解釋實驗結果的無能為力。衷心感謝的是帶我入門的學長，以及具備深厚物理知識的陳宜君教授，總是能深入淺出地指導相關物理概念與依循經驗，讓底子薄的我能在此領域越走越遠。而在掌握了各式量測與分析技術之後，十分幸運能遇到當時新進的楊展其教授。楊教授專精的材料製程設計與源源不斷的點子讓我能不間斷地測試其可行性，終於在一連串的修正後能有現在能足以自豪的成果，也在此過程中建立更紮實有效的研究實力。由於實驗繁忙而總是難以抽空回家看看，感謝家人的體諒與支持，讓我無後顧之憂。最後要感謝中技社對於學生的肯定，學生將銘記此榮譽以及對我的鼓勵，努力深造自己，期許未來能在紮實國內學術實力之餘，還能為國家科技研發產業做出貢獻。

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