Photo induced effects in ferroelectric thin film based devices

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Ferroelectric materials exhibit coupled degrees of freedom and possess a switchable electric polarization coupled to strain, making them good piezoelectrics and enabling numerous devices including non-volatile memories, actuators and sensors. Moreover, novel photovoltaic effects are encountered through the interplay of electric polarization with the materials optical properties. Consequently, the light-induced deformation in ferroelectrics, or photostriction [1], combining photovoltaic and converse piezoelectric effects, is under investigation in the quest for multifunctional materials. Recent studies in ferroelectric thin films have reported photo-induced strain in the picosecond time range [2-6], thus opening a new route for ultrafast strain engineering and optical actuation in devices. However, the polarization is usually in as-grown state, so its contribution on the photostrictive response is not well understood.

I will present our recent studies on the control of photo-induced current and photo-induced strain by tuning the ferroelectric polarization in thin films based devices. In particular, time-resolved x-ray diffraction studies performed at Advanced Photon Source (APS) revealed that both magnitude and sign of ultrafast strain can be controlled by the polarization state (Figure) [7], giving a better understanding of the ultrafast photostriction mechanism in ferroelectric devices. These results provide fundamental insight into light-matter interaction in ferroelectrics and exciting new avenues for materials functionality engineering.

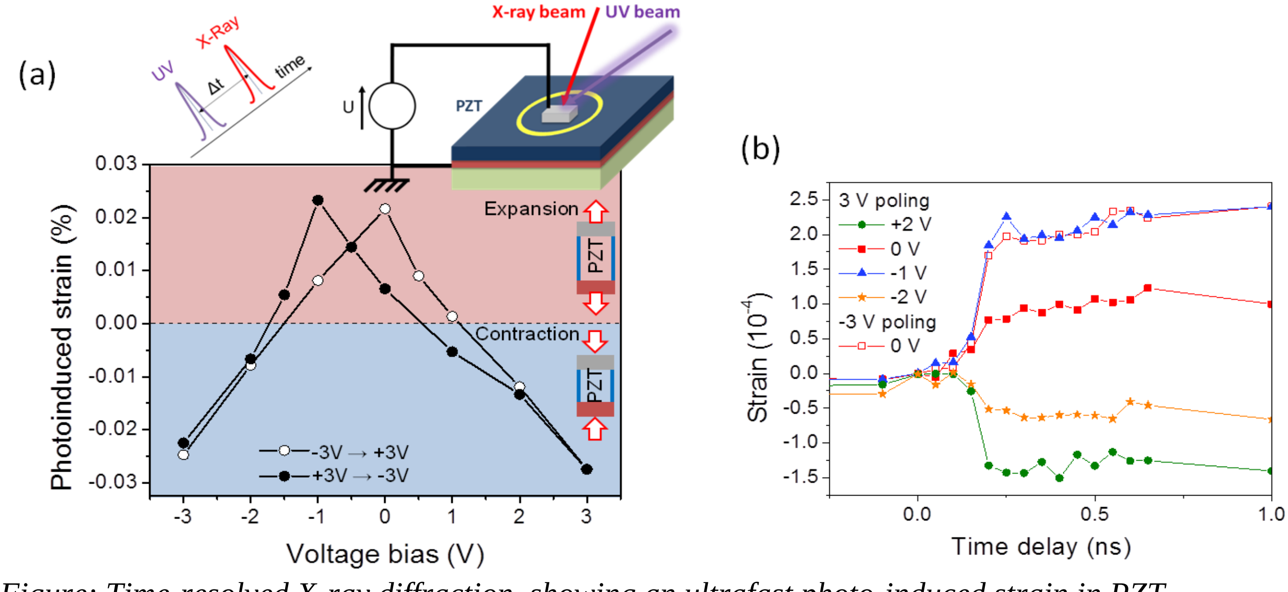

Figure: Time-resolved X-ray diffraction, showing an ultrafast photo-induced strain in PZT microdevices whose magnitude and time response can be tuned by applying in-situ electric field, through changes of the polarization state within the ferroelectric thin film [7]. (a) Strain induced 2.5ns after a 6.22 mJ/cm² absorbed UV pulse (at 320 nm wavelength), as function of applied voltage allowing to control both sign and magnitude. (b) Strain dynamics, as a function of delay, induced by the UV pulse for different applied voltages.

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